Journal of CHEMICAL EDUCATION

VOLUME 23 — October, 1946 — NUMBER 10

Published by the
DIVISION OF CHEMICAL EDUCATION OF THE AMERICAN CHEMICAL SOCIETY

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Subscription Price: Domestic $3.00 per year; Countries in Pan-American Union $3.00 per year; Canada $3.50; other countries $4.00. Issued monthly. Single copies of issues in current year, 50c each; all other single copies, one dollar. Foreign remittances must be accompanied by International Money Order.

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Entered as second-class matter, January 31, 1924, at the Post Office at Easton, Pa., under the act of March 3, 1879. Accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924.

The JOURNAL OF CHEMICAL EDUCATION *is the official organ of the Divisions of Chemical Education and History of Chemistry and incorporates the Report of the New England Association of Chemistry Teachers. It is indexed in the Education Index, Industrial Arts Index, and, in part, in the Quarterly Cumulative Index Medicus*

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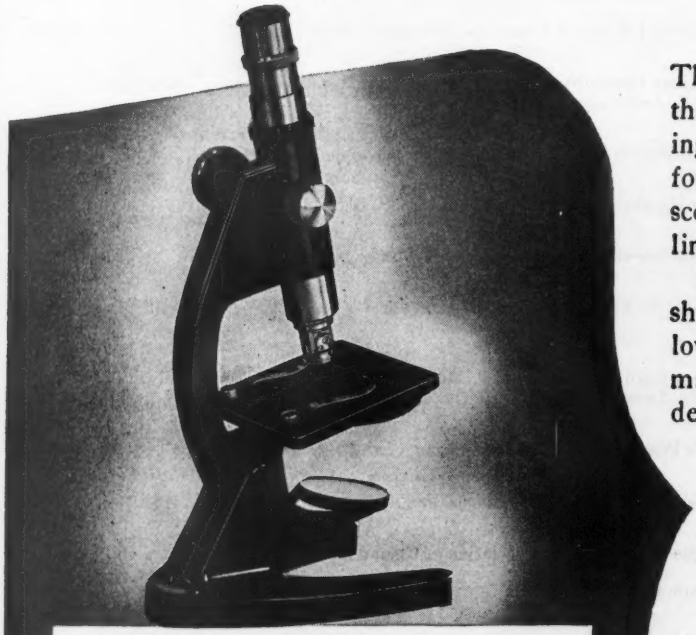

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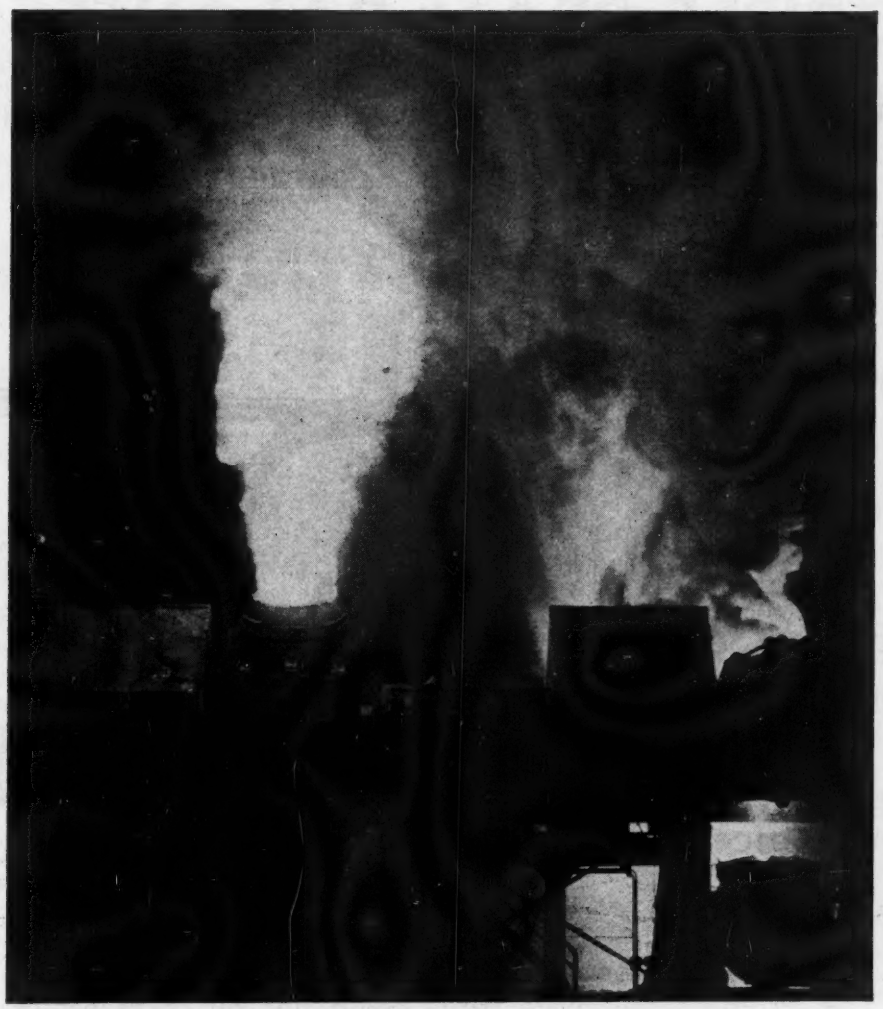

Bessemer Converters Blowing for Peace

(*See page 470*)

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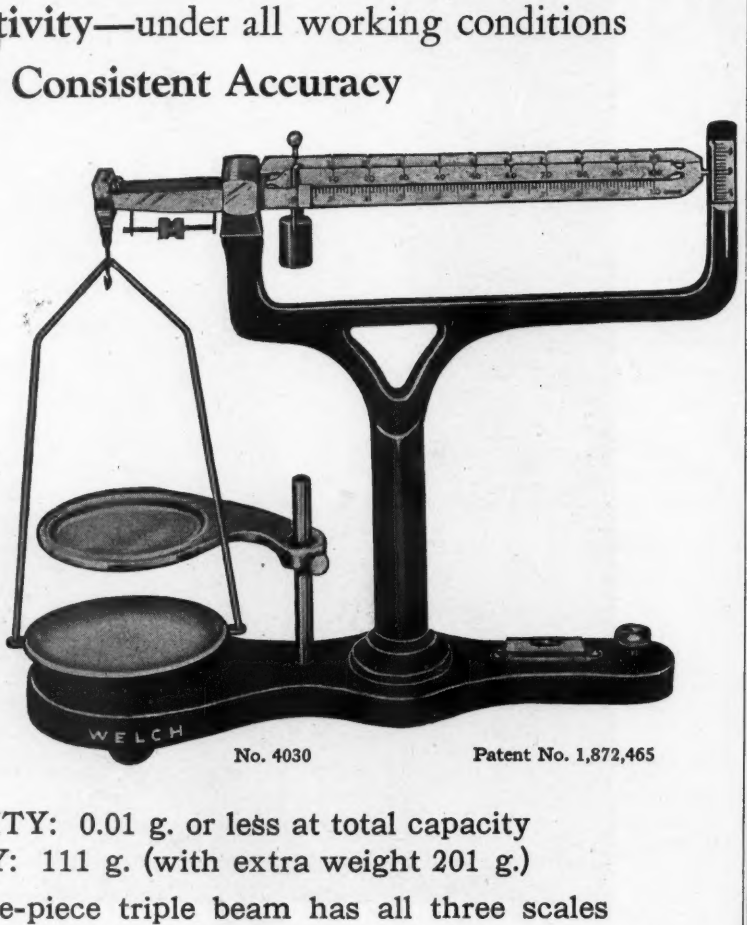

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Editor's Outlook

IT IS not long since we passed "the Crossroads." (How appropriately named were the bomb bursts at Bikini a few weeks ago!) A recent editorial entitled "Operation 'Beyond the Crossroads' " points out that the tremendous advances in the physical, chemical, and biological sciences are rapidly rendering obsolete many of our habits, traditions, and customs in the fields of social relations, politics, economics, and statesmanship.

The people of the world, it is pleasing to note, have become science conscious. Although still mistrusting science's motives in view of the ravages and destruction which the application of scientific discoveries has inflicted upon agonized mankind, the people are clamoring for fundamental truths and values. They are begining to realize that science is not to blame for the misery and devastation wars bring, that science can be the greatest friend of man, that in it lie man's hope and promise for a better world—if only we resolve to use science for constructive rather than destructive purposes . . . . The "Brave New World" is by no means a dream; it lies within our reach and is going to materialize if we resolve to have it. On the other hand, oblivion and chaos lie within easier reach, should we prefer this.[1]

Scientists themselves, on the other hand, are becoming more conscious of the problems of social relations, politics, economics, and statesmanship. This is significant and fortunate, and although some people feel that scientists in their efforts to be vocal in such matters are mere amateurs in a foreign field, nevertheless, they are certainly better informed and more effective than the average man, upon whom our democratic institution is based.

We have a big problem on our hands, trying to make the world safe from itself. For any kind of solution, the problem demands attention from all of us, high, wide, and handsome.

While not the only cause for concern, the specter of more and bigger wars is certainly the most gruesome. New sources of explosive energy, in new and more frightful weapons, make it impossible to disregard the possibility and the consequences. No one knows this better than the scientists, who are technically responsible for the condition. Their awareness is evident from their efforts to raise a united voice, to influence domestic and international decisions of great importance.

The War is over; long live the Peace! But how to do it? True to their habit of striking directly to the core of a problem, many scientists advocate immediate steps toward One World Government. If we stood half a chance of establishing such a government, *on our terms*, we would all flock to the banner. But, like our hopes for Heaven, it is probably in the dim future. Furthermore, Hitler was suspected of having a world government plan, which we nipped in the bud.

Certain groups would have us believe that the man who keeps a loaded pistol in his house for protection is bound to shoot someone with it sooner or later. Personally, my pistol has been up on the shelf for a good many years, my police record is still clear (more or less), and I sincerely hope that the old gun isn't rusted beyond the possibility of emergency use.

Let us remember that we haven't had much experience playing marbles with The International Gang. They play for keeps, and now that we have come out from behind the bushes and propose to *lead* the gang, we may expect to have to slap somebody down sometime and get our hands dirty. Many of those fellows were brought up on the other side of the railroad tracks and don't play the game according to our rules (or any rules, for that matter). They don't like Little Lord Fauntleroy very much because he has superior manners and lots of marbles, and they would just love to soil his white collar. Little Lord Fauntleroy would do well to have a pair of brass knuckles in his pocket and know how to use them.

The amount of money spent regularly on preparedness for national defense irks us; it is wasted money and could accomplish so much if spent in other ways. But so is our fire insurance premium wasted money—if our house doesn't burn down.

Some of us, from our experiences in the recent war, have reason to distrust the military institutions. But for all this they are going to be very necessary to us, and instead of grousing, scientists would do much better to cooperate and try to remove the reasons for such distrust. The Army is well aware that its existence is not the permanent solution of the problem of peace. This is evident from the recent report to the General Staff which came to the conclusion that the only really safe policy of national defense was avoidance of the causes of war by concerted international action. But nevertheless, while we push with all our might for the success of the United Nations (and our country is reported in international circles to be doing this more effectively than any other), still the Army, the Navy, and the Air Forces have not yet outlived their usefulness.

Twice within a generation we have been caught with our defenses down. We have demonstrated our fundamental peaceful intentions at some considerable cost and pain to ourselves. Surely no nation can be thought bellicose and a threat to world peace for refusing to be taken for a sucker a third time.

(*Continued on page 519*)

[1] *Can. Chem. Process Inds.*, **30**, 27 (1946).

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WHEN the National Emergency arose, research was already organized, entrenched, and functioning in the steel industry. The development of basic material for armament and munitions did not have to start from scratch. A vast fund of metallurgical and engineering knowledge had been accumulated, and experience in producing steel to the exacting requirements of the diversified manufacturing industries of this country was extensive. Emphasis had to be shifted to accommodate the specific demands for grades of steel with special combinations of properties, but the high level of existent knowledge served as an excellent starting point. The general "know how" in research was on hand awaiting application to the problems involved in the production of steel for designated purposes of combat.

As is usual, the pace of research and development was greatly accelerated by the advent of war. Normally moving projects became urgent; different parts of the field were explored; the tempo of all necessary investigations was quickened. Speed became a more important ingredient in all programs of research. As a result of the acceleration, a large dividend of additional knowledge has been added to the yield of normal developments for the period in question.

Dr. E. C. Bain, Vice-President, Research and Technology, Carnegie-Illinois Steel Corporation, a subsidiary of United States Steel Corporation, well summarized the problems involved in steel research in a talk before the Canadian Institute of Mining and Metallurgy:

Good research is that which is so planned and carried out as to yield the most new knowledge, in a systematic and usable form for the least expenditure of time, effort, and materials. It usually takes a certain pattern. First the literature is read, not too submissively or credulously, lest one fit one's thoughts to the inadequate mold of the predecessors whose horizons it is proposed to widen. With free play of the imagination and the repetition of some former work in the field, maximum familiarity is gained. After thought, the research worker usually is able to draw up a plan based upon some such tentative hypothesis as the following: "I could improve the product if a higher temperature retarded the rate of the unfavorable reaction; this could be true for certain altered compositions." The test of this prediction experimentally then becomes a "critical experiment." The critical experiment, however, should always take the form of a series of measurements of an effect caused by the systematic variation of some influence, be it temperature, pressure, time interval, or composition. Such experimentation is really never unsuccessful, for the information derived is inevitably useful in prosecuting the work. In the simplest terms research is a repetition of the second and third steps, *i. e.*, making the tentative hypothesis and performing a systematic investigation of its validity and significance.

This simplified description of research suggests the activities of an individual worker. Since World War I, in particular, group research has flourished by virtue of its great effectiveness for larger problems. Here it is customary for a group to confer upon the analysis and statement of the problem and to divide the work into more graspable parts. Such groups quite properly operate best with good coordinating supervision—that is, organization. The precise type of organization is of importance secondary to that of the mental attitude of the workers, particularly of the supervisors. There must be in the approach to the work a kind of optimism which supplies a deep conviction that something is to be learned.

Among the matters which appear as certainties and

which may fundamentally be attributed to intensified research during the past few years, mention may be made of the general improvement in steel quality resulting from advancements in the steel-making processes. Continued study of the physical chemistry of steel making, contributing to better regulation of metallurgical reactions, slag composition, temperature, and degree of deoxidation, has led to greater refinement in practice and better control of product. The great increase in capacity during the war years has brought with it some of the finest and most improved equipment—mechanical, thermal, and electrical—ever devised for the production of steel products. The selective use of this equipment by the industry should be possible.

E. C. Wright, Assistant to the President, National Tube Company, a subsidiary of United States Steel Corporation, in a paper on "The manufacture and properties of killed Bessemer steel" presented before a meeting of the American Society for Metals early last year, called special attention to how analysis of basic principles has made possible an important advance in the art of steel making. He said, in part:

A survey of the physical-chemical conditions surrounding steel making and deoxidation enabled National Tube Company to measure the deoxidizing power and efficiency of various addition agents and also pointed out the important effect of temperature upon this chemical reaction. Thorough study of the literature on the physical chemistry of steel making facilitated the calculation with considerable accuracy of the effectiveness of the available deoxidizers.

Carbon is a much more powerful deoxidizer than silicon or manganese at temperatures above 1600°C. (2910°F.) when the carbon content of the bath exceeds 0.10 per cent. As the temperature of Bessemer steel generally exceeds 1600°C., attempts were made to deoxidize blown Bessemer metal with additions of carbon and eliminate the oxygen in the bath as carbon gases instead of producing solid precipitated oxides, such as SiO_2 and Al_2O_3, which remain to a considerable extent as inclusions in the steel. The simplest and most thorough method of treating a blown converter bath with carbon is to add hot metal which contains approximately four per cent of carbon as well as some manganese and silicon. This is the same metal as is ordinarily charged into the Bessemer converter and is the blended product of one or more blast furnaces, normally held in the hot metal mixer for use in either the Bessemer or open hearth operations. The action of such additions to fully blown Bessemer heats gave a very thorough deoxidation, much like the "blocking" of an open hearth heat by the addition of ferro-silicon or spiegel.

For example, two 25-ton heats of Bessemer metal blown to 0.04 per cent carbon were treated with 1400 pounds of hot metal, added in each vessel after blowing, and then poured into a 50-ton ladle. If no reaction occurred, the carbon content of this mixture would approximate 0.16 per cent. Mixing of the blown metal and hot metal in the vessel is almost instantaneous, and the elimination from the metal of carbon and oxygen in the form of CO gas is extremely rapid, a large puff of flame appearing over the mouth of the converter just after the molten iron addition.

In 100,000 pounds of blown metal containing 0.08 per cent oxygen, the amount of oxygen is approximately 80 pounds. Twenty-eight hundred pounds of hot metal with 4.25 per cent carbon and 1.5 per cent silicon contains 119 pounds of carbon and 42 pounds of silicon. The 80 pounds of oxygen should require 60 pounds of carbon for deoxidation. It is assumed that the finished steel contains 0.015 per cent oxygen, as thoroughly killed heats show this amount in several analyses. The oxygen removed is thus 65 pounds, requiring 48 pounds of carbon. The 119 pounds of carbon in the 2800 pounds of hot metal is partly eliminated as CO gas, and the carbon content of the resulting steel increased from approximately 0.04 to 0.12 per cent, indicating a carbon-oxygen equilibrium at 0.12 per cent carbon. This increase in carbon content of 0.08 per cent in 100,000 pounds of blown metal requires 80 pounds of oxygen. Accordingly, the 40 pounds of carbon has reacted with 53 pounds of oxygen. This result demonstrates that most of the oxygen in the blown metal is eliminated as CO.

After this reaction, the steel may be treated in the usual manner with the proper additions of ferro-silicon, one to three pounds of aluminum per ton of steel, and sufficient ferro-manganese to give the final manganese content desired in the ladle. The efficiency of the manganese and silicon additions to the ladle is as high as in the case of open-hearth heats tapped at the 0.12 per cent carbon level. The accompanying table shows the chemical balance between the additions in the example given.

The carbon content of the steel may be raised to any level desired by increasing the amount of hot metal used; satisfactory heats with carbon as high as 0.45 per cent and over 1 per cent manganese have been made. The use of hot metal additions to open hearth heats, instead of ferro-silicon or spiegel additions in the furnace, has also been successful. The higher temperature of the Bessemer steel as compared to the usual temperature for open hearth steel apparently makes the molten iron more effective as a deoxidizer in the Bessemer heats.

The effectiveness of this development is well demonstrated by the experience obtained during the past six or seven years. During this time well over 700,000 tons of Bessemer steel ingots have been produced by the new improved process, and some 460,000 tons of seamless pipe and tubing made from it, these products representing one of the most severe tests that can be made of the quality of any steel.

Wartime research has greatly intensified the study of the alloying elements in steel, making for a more rational use of these components in setting up desired combinations of properties. The trend away from an excessive number of grades of alloy steel was well under way before the war, and interested technical groups were working upon a simplification of the unwieldy list of specifications. Under the conditions of national emergency, recourse had to be taken to progressively smaller lists of permissible grades, until finally the matter became critical, and the number was reduced, by official directive, to a minimum. A special aspect of the work on alloy steels was the development of the National Emergency Steels to meet the crisis caused by the too rapid exhaustion of our available supply of such metals as chromium, vanadium, nickel, and so forth. The NE steels were designed to make the most effective use of the strategic materials on hand, utilizing the alloy content of carefully segregated scrap in so far as possi-

CHEMICAL BALANCE IN A KILLED BESSEMER HEAT

	Blown metal, 100,000 lbs.		*Molten pig, 2800 lbs.*		*Ferro-manganese, 600 lbs.*		*Ferro-silicon, 500 lbs.*		*Final heat, 103,900 lbs.*		*Addition efficiency,*
	Per cent	*Weight*	*Per cent*	*Weight*	*Per cent*	*Weight*	*Per cent*	*Weight*	*Per cent*	*Weight*	*Per cent*
Carbon	0.04	40	4.25	119	7.00	42	...	...	0.15	156	74.00
Silicon	0.008	8	1.50	42	...	...	48.00	240	0.21	218	74.50
Manganese	0.05	50	0.60	17	78.00	468	...	...	0.436	453	83.20
Oxygen (0.36 per cent FeO)	0.08	80	...	...	...	...	...	...	0.015	15	...

ble. Metallurgically they relied in most instances upon the cumulative effect of relatively smaller amounts of multiple alloying elements rather than upon that of larger percentages of one or two.

Another interesting development is that of the so-called "intensified steels." They are designated as such because in their making there is added to the molten steel, after it has been deoxidized, one or another of a group of rather unusual metallurgical agents which intensify the hardenability effects of the more common alloying elements. There is quite a variety of these addition agents, but they all contain boron in some form; hence in some quarters the treated products are commonly referred to as "boron steels."

These steels were applied in substantial tonnages to war requirements which have peacetime equivalents. Work on this development started some years before the war, but it received its principal impetus and came into fruition during the war period. Further research work is in progress on an extensive scale, and metallurgists look for a considerable increase in the use of the intensified steels.

An immense amount of work has been done on the heat treatment of steels. Existent technological data have been fortified by additional intensive studies. Precise procedures and properly regulated cycles, based upon detailed metallurgical investigations of the steel to be treated, have been devised and specified. They have been implemented with adequate equipment, controlled by excellent instruments, and followed by heat treaters enthusiastically because of the superior results achieved. This advancement in the science and practice of heat treatment, fostered as a necessary part of the war effort, will be a boon to both the manufacturer and user of steel.

Matching in importance the developments in heat treating is the forward sweep of welding as a tool of fabrication. Without the modern techniques and practices of welding the amazing performance of American industry in meeting the requirements of the armed services would not have been possible. Grades of steel which a few years ago were not considered commercially weldable are now yielding satisfactorily to the operation, as a result of concerted study and effort. Because of the widespread use of welding in its various forms for so many purposes, weldability as a characteristic of any steel offered for sale is becoming a primary consideration.

Continued research throughout recent years has contributed much to the development of steel products electrolytically coated with tin, zinc, and other metals. When the Japanese occupied the major tin-ore producing areas, this country was forced to develop other sources and conserve the pig tin already on hand. A process of evenly applying a thinner coating to the steel strip from which tin cans are fabricated, even though the normal coating is measured in hundred-thousandths of an inch, was at that time about ready for commercial use. It was immediately put into large-scale operation. The process consists of passing steel strip continuously through a solution containing tin and electroplating about one-third as much tin on the strip as had formerly been applied to the cut sheets by hot dipping. That in itself sounds simple; yet this new type of tin plate involved studies in steel rolling, annealing, and cleaning, as well as in gas equilibria, electrochemistry, the physical chemistry of surfaces, surface tension, electronic devices, and other phases of science.

Before the war stainless steel that was highly resistant to corrosive attack could be hardened only by cold working, which severely limited its application in many fields of industry. Research, however, perfected a new form of stainless steel, known as "Stainless W," just as war needs required it. This was held as a secret during the war and has only recently been publicly announced. The new stainless steel is "precipitation hardening," *i. e.*, can be hardened by a simple reheating operation even in large sections or shapes previously formed in a softer condition. It also has magnetic properties formerly thought impossible to attain in a highly corrosion-resistant stainless steel and holds many attractive possibilities to the chemical and petroleum industries, among others.

The many advances in steel technology call for a broad training on the part of young men entering the steel industry, and the various aspects of chemistry play an important part in their education. Mr. E. C. Wright of the National Tube Company reviewed this matter of training admirably in a recent talk before the American Institute of Mining and Metallurgical Engineers, saying, in part:

Experience shows that it takes from five to seven years to make an able metallurgical engineer in a steel plant. The finished metallurgical engineer requires a thorough understanding of routine analytical chemical work, routine physical testing procedure, a good knowledge of statistics, ability to handle men, a thorough knowledge of all the processes and operations in the plant, and finally, ability to analyze difficulties and conduct research work.

It has been found beneficial to place metallurgical engineering graduates in a routine analytical chemical laboratory for a period of three to six months and, generally, if a student has had good theoretical chemical training previously, within three months he can achieve an output which approaches that of the older chemists. This work gives the student a thorough grounding in chemical and metallurgical calculations which he will need later in conducting calculations involving smelting and processing in blast furnace and steel melting operations.

Three to six months on routine physical testing is also necessary. Statistical summaries of physical test results on materials made in large volume are usually assembled in the laboratory and teach the student engineer an early familiarity with statistics which has been found of great value in studying mill problems of a metallurgical nature. The next step is several months in the metallurgical laboratory. The final important part of the training is that of becoming familiar with the specifications for the steel products being manufactured, by passing on inquiries and clearing orders before placing them in manufacture, which requires a detailed review of each specification.

Usually two months observing work will give an intelligent student a fair cross section of the operations and processes of any one department, and it is usually the policy to rotate observers through the various important departments in the mill from melting to finishing.

A student engineer who has been in observing work for one or two years, which approximates a total of three years in the plant in question, has reached a stage where it is possible to assign him

more responsibility and allow him more initiative in studying problems. At this point he passes on to research and development work where he is assigned one or more problems with the assistance of other laboratory men for study. Student engineers at this stage rapidly show their ability and true quality. This part of the training program has been very beneficial to the men of better quality and also supplies a continuing group of younger men to the research laboratory organization who are familiar with manufacturing operations in the company's plants.

During this period of the student's development the question of writing reports also arises, and for many this seems very difficult. In the beginning this appears to be largely due to the young engineer's obsession with his own research work, and an assumption that the report need cover only the briefest details. He fails to realize who will later read the report and generally fails to state clearly the problem, methods used in overcoming it, and definite conclusions as to the results. It ordinarily takes from one to two years of continual report writing to demonstrate to a young engineer what is required in a finished report. A well-written report, however, has often attracted the attention of a higher executive to a young student and has many times hastened promotion to a better position.

After about five years in a steel plant the metallurgist is ready to meet customers and to discuss with them the metallurgical factors relating to the use of the product in the consumer's plant. He must, therefore, know not only the various properties of his own material, but he must also be familiar with the tolerances, range of sizes, finishes, and other particular details of the materials under discussion. Experience of this nature gives him a realization of a customer's problems, and he returns to his own plant with the aim of improving the product being made to meet, as far as possible, the desire of the user. The metallurgical engineer who exhibits sales and business ability will be the steel salesman of the future. Men who have concluded the mill training are generally outstanding and achieve fairly rapid promotion because of their thorough knowledge of the company's manufacturing procedures.

Based on 25 years of experience, five in engineering schools and 20 in the steel industry, it appears that graduates of standard engineering colleges are readily adaptable to actual work in steel plants. Moreover, while the graduates from engineering schools have somewhat better training in physics, mathematics, and engineering, it has been a general and continuing observation that most of the students employed had had inadequate training in the fundamental sciences, such as physics, physical chemistry, thermodynamics, and any form of mathematics higher than simple calculus. For example, it has been frequently noted that young engineers faced with problems in a mill which involve some mathematics generally flounder badly and that they had little conception of physical chemistry. Another common deficiency lies in the young graduate's lack of knowledge of where to look for the more detailed literature on any subject. An engineer with a sound foundation in basic science can readily adapt himself to any metallurgical industry by means of a few months' study of its literature while working in the industry.

This article is necessarily only a short summary of what has been happening to the technology of steel during the war and is indicative rather than comprehensive. To go into such matters as the influence of compressive stress on the fatigue endurance of steel, the latest procedures for crackless hardening, or further details of the improved Bessemer steels, would take up more space than is available. It may, however, be said that during the past four or five years the accelerated development of knowledge in regard to the production, treatment, selection, and utilization of steel has achieved what would normally have been done in ten years. It has, therefore, tremendously broadened the horizon for technically trained men not only in the steel industry but in all the fields of endeavor associated with it.

Changing Phenolphthalein from Colorless to Pink by Adding Acids

LEON McCULLOCH

Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania

THE pink color of phenolphthalein in strong solutions of sodium hydroxide fades and the solution becomes colorless, the change being reversible. If the solution is largely diluted, the pink color reappears after a time—rapidly on heating.

It may not be known that the reversal from colorless to pink can take place immediately by adding a few drops of strong acid to the dilute colorless alkaline solution. This unusual reaction could be demonstrated before an audience to excite curiosity and might even lead some student to inquire into the molecular rearrangements involved.[1]

Prepare a solution of sodium hydroxide and water in equal parts, add phenolphthalein in alcohol, and let stand until the pink solution becomes colorless. Dilute to about ten times its volume and it remains colorless still.

Into a portion of the colorless alkaline solution in a test tube, add a few drops of hydrochloric, nitric, dilute sulfuric, or phosphoric acid. The alkaline solution immediately turns pink. Excess acid, of course, makes it colorless as usual in acid solutions. The change may be produced also by formic acid but not by acetic. Neutral salts are without effect.

The strong acids seem to act as catalysts of the color-producing reaction in the phenolphthalein. The slight temperature rise caused by the neutralization of the acid by the base does not account for the accelerated reversal. Much higher temperatures are required to produce the change in similarly short periods of time.

[1] The rearrangements in phenolphthalein are discussed by R. C. FUSON AND H. R. SNYDER in "Organic Chemistry," John Wiley and Sons, Inc., 1942, pp. 472–3, and by C. A. PETERS AND B. C. REDMON, J. CHEM. EDUC. 17, 525–9 (1940).

The Technical Library of Tomorrow[1]

NORMAN C. HILL[2]

Pittsburgh Coke & Chemical Company, Pittsburgh, Pennsylvania

THE TECHNICAL LIBRARY OF TODAY

PERHAPS the best approach to the technical library of tomorrow is to study its counterpart, as it is now being operated. Some technical libraries are well on their way toward the ultimate. Some have already reached the state of near-perfection as viewed by today's standards. Many, however, have just been well started, while the others lie some place between these extremes.

Some companies do not have a technical library. True, there are some technical books in the plant manager's office. The routine laboratory has half a dozen standard volumes on analytical chemistry, and it may have a few copies of A.C.S. journals, the property of one of the more enterprising members of the staff. The research group, if there is one, is probably likewise poorly equipped, both in buildings and equipment.

Some companies have taken an old room, generally inaccessible, possibly in a building separated from the laboratory or office, and have converted this into a so-called technical library. It is usually not well equipped, no attention has been given to its future growth. It may be poorly lighted, dusty, and the furniture may be uncomfortable.

It may be operated by untrained or poorly trained personnel, if it is attended at all. It may have a poor book collection—cast off or left-over books. The lack of technical journals covering the field of the plant's endeavor is at once apparent. These libraries have just been started. Those in charge have a long way to go to reach the high state of "near-perfection."

THE TECHNICAL LIBRARY OF TOMORROW

The technical library of tomorrow will be quite different from some of the "technical libraries of today." It will be housed in proper, accessible, well-lighted rooms, with comfortable furniture and with necessary arrangements made for expansion. Proper stacks, cases, and catalog equipment will also be provided. The library will be well cataloged and well operated. It will have a good current book collection, and the journals also will cover the field of the laboratory's or the plant's endeavors. Most of the technical collection, both journals and books, will be on microcards, filed under title, subject, and author entries. Other modern equipment will be found in the "Technical Library of Tomorrow," some items of which we describe later in this paper.

THE WORLD'S TECHNICAL ADVANCE

We all believe that technology has advanced farther and faster in the past ten years than ever before. We cannot take time to list, much less discuss, the many new and improved lines of research and development. The flood of technical literature from the plants and laboratories all over the world—including the many published reports originating in the United States and the still greater number of *unpublished* reports, the many enemy-source reports, the unpublished government research reports on petroleum, rubber, and several thousand O.S.R.D. and other government research projects, Army and Navy technical reports which may never become public but yet must be handled, studied, and referred to within the "inner circle"—all of these and the usual "run of the mill" technical publications form a "mountain" of technical literature to be worked over by chemists, physicists, metallurgists, chemical engineers, mechanical engineers, electrical engineers, and other technologists assisted by librarians; and this technical literature must be put into condition for both immediate and future use.

Improvement in the handling of technical reports and ideas contained therein will result in additional technical advance, since any part of the work done, either in one laboratory or in the whole of the published literature, may be compared with any other part thereof and logical conclusions drawn, if these several parts of "the literature" are readily available.

There is need, therefore, of instantaneous response when a particular journal or a book is needed—without waiting for a messenger to secure it or waiting until time is available to get out the company car to go to a nearby library. Such methods result in allowing the impulse to "cool off" or "slow down." Instead, the whole of the chemical or other related literature should be instantly and easily available.

The "negative" qualities of some of the "Technical Libraries of Today" should thus be completely removed

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8–12, 1946.

[2] Present address: Chief Chemist, U. S. Synthetic Rubber Laboratory, Akron 1, Ohio.

on Technical Library Techniques

and the proper substitutes made in order that the "Technical Library of Tomorrow" may properly fulfill its mission.

WHAT SHALL WE DO FIRST?

Probably the first thing to do is to secure a properly trained librarian. "Librarians" fall into one of the following classes:

Grade A: Technologist with both technical and library training.

Grade B: Technologist with technical training only, acquiring Library Science training while proceeding with the job.

Grace C: Trained librarian, acquiring needed technical training by attending night school or special classes.

Grade D: Trained librarian, not acquiring needed technical training except by contact with technical articles and remarks of the library clientele.

Grade E: Library clerk with neither technical nor library science training.

Circumstances may cause the laboratory or research head to be the library head also, since "C," "D," or "E" persons may have to be used. Such persons can improve their grade or rank and ultimately become grade "A" librarians. Gustav Egloff, Mary Alexander, Nancy Corbin, and Prudence Van Arsdell have prepared a series of papers, which cover the training of a person engaged in chemical literature research.[3, 4] Neil Gordon[5] has also presented a paper in one of our Symposia entitled "Training of specialists for scientific literature research." All of these papers indicate the degree of training required to do a real job in the handling of technical literature.

The Technical Library of Tomorrow will be properly staffed with trained personnel. Dr. Vannevar Bush, Director of Office of Scientific Research and Development, writes:[6]

> There is a growing mountain of research. But there is increased evidence that we are being bogged down today, as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember, as they appear. . . . Professionally our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for their purpose. . . . Those who conscientiously attempt to keep abreast of current thought, even in restricted fields, by close and continuous reading might well shy away from an examination calculated to show how much of the previous month's efforts could be produced on call. Mendel's concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it; and this sort of catastrophe is undoubtedly being repeated all about us, as truly significant attainments become lost in the mass of the inconsequential.
>
> The difficulty seems to be, not so much that we publish unduly, in view of the extent and variety of present day interests, but rather that publication has been extended far beyond our present ability to make real use of the record. The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentarily important item is the same as was used in the days of the square rigged ships.

Dr. Bush suggests in the same article some new developments for the research worker. We feel that the technical library will proceed hand in hand with the research laboratory in using, filing, indexing, and cataloging the pictures, super microfilms, and records, and even in handling the memex itself. Dr. Bush's suggestions include:

The Cyclops Camera: A small camera, the size of a walnut, takes pictures three millimeters square, using a universal-focus lense and automatically adjusted exposure. The film will take 100 exposures with a single loading and is operated by a spring motor which is wound when the camera is loaded. Color film will probably be employed. The finder will be etched on the operator's right eye-glass lens. The scientist of tomorrow as he moves about the laboratory or on a field trip will take all the pictures he requires for his scientific work, with a minimum of effort. Dry photography is proposed for this purpose. Some of the necessary developments are discussed before this camera can be placed on the market.

The Super Microfilm: Super microphotography is predicated upon securing a linear ratio of 100:1 step-up, whereas only 20:1 is now possible. When this becomes possible, the bulk of the *Encyclopedia Brittannica* could be reduced by a factor of 10,000—its 25,000 pages would become 2.5 pages—or allowing for margins, it could be copied on two $8^1/_2 \times 11$-inch sheets of film and could be reproduced for a material cost of about five cents and could be mailed for one cent. Such a development will make possible the "Memex."

The Vocoder (Super Secretary): The Voder at the New York World's Fair produced speech by mechanical means. Dr. Bush has suggested reversing the operation. If the human voice actuates levers like the stenotype machine, it would seem possible that speech could be transformed into the typed word. Reports would then give us no trouble.

The Thinking Machine: Physicists constructed thermionic units capable of counting electrical impulses up to the rate of 100,000 per second. The advanced arithmetical calculators of the future will be electrical in character. They will perform at 100 times

[3] *Bulletin No. 259*, Universal Oil Products Company, Chicago, Illinois.

[4] ALEXANDER, M., N. CORBIN, AND G. EGLOFF, THIS JOURNAL, **21**, 615–9 (1944).

[5] GORDON, N. E., THIS JOURNAL, **20**, 369–72 (1943).

[6] BUSH, V., *Atlantic Monthly*, **176**, 101 (July, 1945).

the present speed or even faster. It will be necessary to adjust them for the type of operation desired; feed in the known data, press the button, and out will come the answer, as does the already developed differential analyzer.

The Memex: This is a coined word used to describe a unit capable of holding thousands of pages of material which have been reproduced from several million original pages. Dr. Bush states that if the user inserts 5000 pages of material a day, it would require several hundred years to fill the repository. It uses supermicrofilm. Notes and sketches, written or drawn on a platen used for studying material from the memex unit, can be re-photographed and placed in the record, to be recalled when needed by using the correct call numbers, operated by levers, buttons, or even by using our present telephone call dial. The operator has the power to tie related items together by "trails"; hence items tied together can be recalled by association, as in the human mind. One can, therefore, "re-think" one's thoughts by using the Memex, as well as throw onto the slanting translucent screen the pages of any book, picture, journal, periodical, correspondence, or any other material he has placed in the Memex. *Reference work may, therefore, be done in a fraction of the time now required, providing the Memex first be filled or supplied with the literature which will later be required.*

The Memex may likewise contain the complete library collection as well as the complete file of all reports, correspondence, and all other papers of the laboratory. As many units of Memex will be supplied as are justified, based upon the number of workers and the type of their work. The Director of Research and Development would, therefore, have *Chemical Abstracts*, as well as all the other reference journals, the entire book collection of the library, all of the blue prints and design data of all of the plants of his company, all of the research reports of his company, all of the patent copies he might need for study in his Memex and still have much unused capacity. Any of these publications could be made instantly available by "dialing" the correct number.

Punched Cards: For study cards, bibliographies, and special studies the "Technical Library of Tomorrow" would have one or both of the punched cards described in this symposium by Messrs. Casey, Bailey, and Cox in their paper, "Punch card techniques and applications," and by Mr. C. D. Gull in his paper, both of which follow.

The I.B.M. sorting unit handles 450 cards per minute or 7.5 cards per second, yet this is not rapid enough. Dr. Bush suggests the use of an electronic device for "scanning" the cards, capable of sorting possibly many times the present rate of 450 per minute. It may thus be able to reach the rate of 1000 cards per second with the proposed scanning type of sorter.

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[7] RIDER, F., "The Scholar and the Future of the Research Library," Hadham Press, New York, 1944.

THE GROWTH OF AMERICAN RESEARCH LIBRARIES

The growth factor of technical libraries must be considered and expansion must be provided in the "Technical Library of Tomorrow." The criterion must be "Do we need this book, this journal, or this micro reader," rather than "There isn't room for any more books, journals, or special equipment."

We have been unable to secure information on the growth of factory and other strictly technical libraries. To secure related information we have gone to two sources:

Miss Blanche McCrum, formerly of the Carnegie Library of Pittsburgh, Pennsylvania, and Washington and Lee University and now Librarian of Wellesley College, has made studies on the growth of college libraries in "Standards for College Libraries." Miss McCrum's study in 1933, covering 72 of the leading college libraries, shows: 31 had equaled or had exceeded doubling every 16th year; 6 had tripled every 16 years; 2 had quadrupled every 16 years; 4 had quintupled every 16 years.

Fremont Rider,[7] Librarian of the Wesleyan University Library, has made an exhaustive study of the growth of American Research Libraries. He had found that the libraries of the smaller colleges double in the number of volumes included in their collections every 22 years; five women's college libraries had doubled every 12 years; ten universities founded since 1849 have libraries which double every nine and one-half years, while the ten older university libraries double every 16 years.

APPROXIMATE SIZE OF LIBRARIES BY VOLUME

	Year			
	1876	*1900*	*1925*	*1938*
Ten smaller colleges dating from 1831	269,240	490,520	1,128,480	1,881,540
Five American women's colleges	38,130	143,735	583,655	962,685
Ten universities dating from 1876	146,420	963,840	4,698,420	7,536,410
Ten universities dating from 1831	593,800	1,870,820	7,441,140	11,829,840
Total volumes in 45 American colleges and universities	1,047,590	3,468,915	13,851,695	22,210,375

If we plot the total volumes in the 45 American colleges and universities against the year of tabulation and read the year, the combined collection was just half of that for 1938, and so on; we have:

Combined collection of volumes in 45 colleges and universities	*Approximate year*
22,210,000	1938
11,105,000	1930
5,552,000	1910
2,776,000	1895
1,388,000	1882

These data, therefore, show that the years required to double the collections in the combined 45 libraries are 13, 15, 20, and 8, or the approximate mean time required to double the collection for the colleges and universities cited is 14 years.

The frequently quoted works of Rider and Bush are important since they suggest improved methods of handling an intricate and difficult problem.

Yale University in 1938 had 2,748,000 volumes, requiring approximately 80 miles of shelving; the card catalogs must have occupied 10,000 drawers. The staff is composed of 200 persons, probably half employed as catalogers, in acquisition, or other preparational processes. At the present rate of growth, by 2040 A.D. the collection shall have reached 200,500,000 volumes, requiring 6000 miles of shelves; the card catalog would then require 750,000 drawers. The accession rate would then be 12,000,000 volumes per year and the cataloging staff would probably be 6000 persons.[8]

Rider's suggestion, therefore, seems to be a logical procedure. Summarized, it follows this plan:

1. Use microcards in place of books, journals, pamphlets, except possibly when a book or journal is issued (current literature).
2. File microcards under author, title, and subject, each a complete micro text; to lend the micro-book card, remove the card, copy all identifying information and name of borrower, and place the card so produced in the microcard file (in place of the microcard). The carbon copy of the request card is then used as the charge slip. The usual reverse procedure would be followed on return of microcard to the library.
3. An alternate plan would be to lend or sell the "borrower" a photographic reproduction of the microcard and thus keep the original file of all microcards intact.

We can thus see that the "Memex" and the Microcard are competing for "place" in the "Technical Library of Tomorrow."

COST OF OPERATION OF THE TECHNICAL LIBRARY

More attention will be given to the cost of operation of the technical library than in the past. A whole morning could be spent on this subject, so I can do no more than just mention some of the factors and suggest a cost accounting form and leave this for someone to develop and present at a later meeting.

The "Technical Library of Tomorrow" will give more attention to its cost of operation; higher efficiency will be secured because of the type of personnel employed, better book collections, and better equipment; more "gadgets" will be used as time savers. More service units will thus be secured per dollar spent in the library.

SPECIALIZED SERVICES FOR TECHNICAL LIBRARIES

Many routine duties and specialized duties of the technical librarian will be taken care of in the "Technical Library of Tomorrow" by special service groups. Times does not permit a long dissertation on this subject. There have been excellent studies on the subject by speakers in our previous symposia, and more recently an article by Francis E. Fitzgerald,[9] "Special librarian and technical progress"; two papers are being given in today's symposium on punched cards which could be developed by special service groups.

These and many other "services" will be developed to assist the technical librarian.

SUMMARIZING OUR CASE FOR THE "TECHNICAL LIBRARY OF TOMORROW"

1. The library will recognize the growth factor and will be planned for easy and inexpensive expansion.
2. It will be properly designed, well lighted, comfortable, and efficiently operated.
3. It will be operated by technically trained librarians, expert in chemistry, physics, chemical engineering, metallurgy, or those branches of science most emphasized by the company operating the library.
4. It will be operated on a cost basis—that is, emphasis will be placed on the cost of operation and cost of service rendered; hence it will tend to be more efficient.
5. It will be operated on a basis which is much more efficient from the point of view of the user's time.
6. It will be equipped with the Memex, rapid copying equipment, super microfilm and microcards, and such other equipment as will assist in operating the library efficiently.
7. It will use both types of punched cards being discussed at this symposium.
8. It will be supplied with many more "services" than are in use today.

[8] RIDER, F., *ibid.*, pp. 10–2.

[9] FITZGERALD, F. E., *Special Libraries*, **37**, No. 2, pp. 35–40.

The American Patent System

Its Relation to Technical Library Techniques[1]

CASPER W. OOMS

United States Patent Office, Washington, D. C.

THE United States Patent Office is probably the largest enterprise which has no other function than the preparation and publication of scientific documents. All of its work begins with the submission of an exposition of original work and ends with the grant of a patent in which the original contribution is defined in a simple abstract.

The nature of this work necessarily renders the Patent Office more dependent than any other institution upon classified and accessible technical materials. The volume of its work renders it imperative that the output be placed in such form and condition that it be immediately accessible to all who would make use of it.

Fundamentally the American Patent System has a single objective. That objective is the encouragement of those who contribute inventions and discoveries to make those inventions known and available to the economic community. As an incentive to inventors and discoverers to make their contributions known, the Patent System offers exclusive opportunity to exploit the contribution for 17 years. Simply stated, that is the full aim and purpose of the American Patent System.

Incidentally, in the performance of this function the Patent System produces accessory effects which in our economy are probably as useful and important as the primary objective which I have just defined. By granting the limited term of monopoly, the Patent System encourages many to undertake original work with the hope that the resultant patent may be profitably exploited. The grant of the monopoly frequently invests its holder with a competitive weapon that permits a small company to overcome competitive advantages possessed by others and thus to increase competition. Finally, the possession of the exclusive franchise to operate in the narrow field defined by a particular patent compels competitors to seek other and different ways of reaching some common desirable end and thus increases the diversity of experiment and enterprise.

In the attainment of these objectives there are a number of simple elementary ends which must be achieved. First, it is important that all patent disclosures be made readily accessible to every worker in industry and science. This is necessary for several reasons, the most important being that the full use of the disclosure upon the termination of the patent can be enjoyed only if the patent's teachings can be easily sought out and located. Hardly less important is the need of those in industry to guard themselves against innocent intrusion upon patented subject matter. There is then the further need that we in the Patent Office must be able to examine the old in the appraisal of each disclosure offered for patenting in order that overlapping patents are not granted upon the subject matter. Finally, it is desirable that every worker in the field have procurable the published work that has gone before, both to avoid duplication of earlier published work and also to have the advantage of background which that earlier work affords in further experiment.

I have frequently raised the question in discussing the Patent System and the considerations which are responsible for its birth and vitality in the United States whether we are not to be defeated finally in the realization of the purposes and objectives of the System by the overwhelming complexity and volume of technical contributions and technical literature that are sweeping over us. We may, unless we develop a system of classification and indexing adequate to meet the demands of this profuse output of ingenuity, erect for ourselves a new Tower of Babel.

We in the Patent Office are particularly concerned with this problem. We are the custodians of the most continuous and voluminous group of documents produced in the United States. The importance of this patent literature in every field is recognized as it has been recognized for chemistry by that distinguished chemist Dr. E. R. Weidlein, Director of the Mellon Institute of Industrial Research, who said recently:

> Issued patents constitute an important, if not the most important, source of information regarding modern technological advances. It is unfortunate that so little attention is directed in our colleges and universities to the body of technical information contained in issued patents. Far better than the average reference texts and published scientific papers, the patent literature mirrors the thinking and day-to-day progress in technological fields.

The United States has since the introduction of its Patent System issued more than two and one-half million patents. The Classification Division of the United States Patent Office estimates that there are at least seven million publications of all kinds now extant even when all duplicated disclosures are excluded. Many of these publications contain more than one distinct disclosure; in fact, some of them include thousands of disclosures. The total number of tech-

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8–12, 1946.

nical publications thus available presents a staggering figure, and the rate of accession to that material is almost beyond calculation.

You who work primarily in chemistry where there are hundreds of thousands of known chemical compounds and even greater numbers of known compositions formed by mixtures of those compounds are daily presented with the problems raised by this enormous accumulation of technical material. Whatever the fact is today, we know that another decade will probably see this accumulated knowledge doubled. No prophetic insight is necessary to realize that the burden of this material is but an infinitesimal fraction of what we within our own lifetimes may yet see produced.

For almost 100 years the Patent Office has been struggling with the probem of classifying technical information in order that issued patents may be available for examination as published art whenever a patent application is brought to the Patent Office for examination as to its novelty, and to render each issued patent accessible so that those who wish to refer to it may find it without any tedious search or great difficulty. We have struggled with that problem, as I have said, for almost 100 years. Today the condition of our work is deplorably inadequate, largely because of the lack of personnel and funds with which to do this enormous job with the thoroughness and with the timeliness that the task requires.

Probably the first requirement of a good classification and indexing system in this rapidly moving technical age is its currency and timeliness. New developments must be made available when the interest in them is greatest, when the art in which they appear is lively, when each published bit of technical information may prove to be the foundation of another development or another line of inquiry. Unfortunately, that is the time when the scope and division of any classification system is most obscure and the actual problem of designing a classification and index is simple only in the fact that the amount of material available is small.

I need cite only one example of what may happen in a rapidly developing technology, the Patent Office's problem arising in the classification of the electron microscope development. Very early in the development of that important instrument a large number of patent applications appeared and it was evident that extensive work was being done. The Patent Office set up a new subclass 49.5, in the established class 250, radiant energy. After only a few years this subclass contains 64 original patents and 73 cross references and is probably the most extensive technical treatment of the subject of electron microscopes in existence.

In contrast with that work, in which the Patent Office was able to maintain currency of classification, is our unfortunate condition in the field of the radio art. The existing classification of that art dates back to 1912. It is also class 250, radiant energy. Subclass 11, which calls for directive radio signaling, contains 1166 original patents and 383 cross references. Subclass 20 for radio receivers contains 2763 original and 1616 cross-reference patents. I might enumerate many other of the radio subclasses which are in equally as unfortunate a condition. Each subclass is practically generic in its scope and contains disclosures of numerous unrelated character. Such, for example, are the numerous types of receiving circuits from the earliest and simplest crystal sets to the latest of present day improvements in frequency-modulated receivers. The labor which a searcher in this art must expend to isolate any single type of instrument is an unnecessary and time-consuming task which could be readily avoided were the classification of the radio art made current.

We have a more gratifying report to make in the chemical field. There is probably no better illustration of rapid growth and continuing need for classification in a particular field than can be found in the field of carbon compounds. Prior to 1924, patents for carbon compounds for the most part were officially classified in two subclasses—that is, class 8, subclass 1 (carbon dyes) and class 23, subclass 24 (carbon compounds). In 1924 class 260 for chemistry, carbon compounds, was established and organized from these two subclasses. At one time the applications examined in that class were handled by one man. After establishment of the new class in 1924 the number of applications grew so rapidly that the services of many examiners were required, and soon thereafter this class had crowded out all other classes in the chemical division.

The 1924 classification was soon outgrown, and the discovery of many new and different types of compounds evaded the subclasses provided. Secrets of the structure of many compounds yielded to the persistence of the research chemist, and a place for each advance had to be provided in the classification. In 1936 work was begun on the revision of class 260, and in 1938 the present classification was published. The work was thoughtfully done with the hope that the organization of the class would be adequate for many years to come and sufficiently flexible to adapt itself to the ingenuity of chemical researchers working in carbon compounds. The Patent Office was aided in this work by a study of the other classifications, particularly that employed by Beilstein in "Handbuch der Organischen Chemie," which appears in about 50 volumes and indexes all chemical literature up to a date appearing on the title page of each volume. In most of the volumes this includes the material appearing up to the year 1919. Further studies were made of the classifications used by private industrial laboratories and those employed in the German Patent Office. Suggestions were solicited from members of the Patent Office Examining Corps and chemists who were making use of the materials in the Patent Office. As frequently occurs, the suggestions provided by workers in the field were as valuable as those found in any published system.

The basic structure of class 260, established in 1938, remains unchanged. Since publication in that year it has been necessary to add over 80 new subclasses to facilitate the finding of newly developed compounds or processes. Our pride in the work is somewhat shaken by

the activity in the field of synthetic resins where we are now in need of many additional subclasses to embrace recently developed types of synthetic resins, such as the silicone resins, polyamides, and melamine-formaldehyde resins. We hope, however, to maintain this class in good working condition, as an example of what may be done when man power and funds are available and the classification work is done with care and persistent attention to the needs of those who work in the field.

However current a classification is maintained, its utility is still restricted by the number of searchers to whom it can be made available. The classification available at one single place is wholly inadequate. Duplicates should be available in well-placed central libraries distributed about the United States and in foreign countries where properly trained attendants can assist in the use of the material. The problem of duplicating material of this kind and making it readily available is to a large extent being met by the universal use of microfilm. That resource still suffers from the one defect that a completed film, like a bound book, cannot very easily be supplemented where the material must be indexed throughout the work.

Our classified material in the Patent Office suffers from one distressing disadvantage. While we have done what we consider an acceptable job with the material of published American patents, with which we are most directly concerned, the inadequacy of our staff and lack of funds for the magnitude of the project have prevented us from paying any such attention to the foreign patented literature or to the published literature in the technical fields appearing in the English and other languages. Even the thought of embracing all of this material in a single classification system is a forbidding one. It would demand a budget far in excess of the six million dollars required to operate the United States Patent Office for a single year. Nevertheless, industry and science are confronted with the fact that until all of this material is made available, not necessarily by a single classification system but rather by all the classification equipment at our disposal and suitable cross-referencing and indexing, both science and industry will suffer an unnecessary limitation upon human accomplishment.

I am not here to plead the case for the Patent Classification System as against all other systems or as the necessary basis for some universal system of classification. We know that other nations have patent classification systems in general similar to our own in many essentials. We recognize that many manufacturers and many government departments have classifications of subject matter specially developed to meet their own particular problems. The chemical profession is particularly fortunate in the various classifications which it has available and unfortunate in the fact that not one of the existing classifications is complete. You have *Chemical Abstracts*, an able and comprehensive work, but for the purposes of examination to determine the novelty of proposed inventions, it is somewhat limited in its utility because of the task required to examine all of the individual numbers and the inspection of a large amount of material not directly relavent to the subject.

You have a large number of publications which collect compositions in particular fields. Most of these are reasonably complete at the time of publication but have no facilities for maintaining them current. You have Gruetzner's *Index of Alloys*, collections of *Glass Compositions*, and many other special works. By far the larger number of all chemical compositions are not classified outside of the Patent Office.

You may wonder at times why we are so stubborn in pursuing classifications that differ in many respects from those maintained by other workers in the field. The explanation is simple. Most material is useful only for the disclosures which it contains. Patents, however, are important during the 17 years of their lives because, in addition to the disclosures which will become generally available at the termination of the patent, the patent contains claims which are the legally effective portion of the patent document. For the purpose of making a purely technical investigation of a field to determine what has been done in it, the disclosure is the only matter of any consequence; however, if a worker in a field wishes to determine whether his apparently original contribution is in fact new and patentable or when an industry wishes to determine whether what it is about to do is free of any patent domination, the claims must be sought out and the limitations prescribed therein examined.

It is the latter function of the patent document which to a large extent dictates the methods pursued by the Patent Office in determining its classification. We submit to the precept that the disclosure must control the classification. Since, however, most patents contain a great deal of environmental disclosure in addition to that specific portion of the disclosure embraced and reserved to the patentee by the claims, the claims portion of the disclosure is selected as the primary basis of classification. When the patent contains two or more related inventions, each covered by a separate claim, each such claimed disclosure is classified in its appropriate place. For convenience in identifying these disclosures and administering the system of classification and indexing, the broadest claimed disclosure is called the original and any other a cross-reference copy. Where there is, in addition to the claimed disclosure, novel subject matter not covered by any claim, this is also cross-referenced to its appropriate place in the system. Thus each disclosure in the patent, claimed or unclaimed, whether for a process, a product, or an apparatus, a generic combination or some simple species, each is classified and indexed so that it may be found.

If the specification of the patent document is designed to disclose what is new, and that is all that a patentee may claim under the law, it is obvious that a great deal of the unclaimed portion of the disclosure found in the specification is merely a recital of old material which doubtless appears elsewhere in the patented art and need not be reclassified each time it appears in a patent document. With these considerations in mind

the basic differences between the Patent Office system of classification and those employed by other authors are readily explained. Take, for example, an invention in a process for making a carbon compound which is of general application to several different groups or types of carbon compounds. To locate such processes in Beilstein, it would be necessary to search the various compounds. In the Patent Office classification it is possible to collect them together. Although the classification in the Patent Office leans heavily toward product classification, which is essentially what Beilstein is, the arrangement is sufficiently flexible to permit the separation of processes applicable generally to groups or types of compounds and the separation of particular types of compounds into groups according to selective structural or functional characteristics.

The Beilstein classification proceeds from the simple to the complex, with the simpler compounds appearing in the lower-numbered volumes and the increasingly complex compounds appearing in the later volumes. The Patent Office classification, on the other hand, proceeds from the complex to the simple, the compounds of simpler structure appearing farther down the lists as complexity in structure is reduced.

The Patent Office has long since discontinued the classification of compounds of known constitution on the basis of formula as being an unnecessary duplication of effort because of the availability of published formulas and indexes.

One fortunate feature of the Patent Office system of classification is its infinite flexibility. Each patent forms a separate document, and these have all the flexibility of arrangement of a loose-leaf notebook. With the numerical indexing which is followed in the Patent Office this system is as flexible as any numbering system can be. We are also in possession of the good fortune that whenever an item is classified, the complete disclosure in the form of a complete patent document appears, and it is unnecessary to refer from index to abstract and from abstract to the original source.

We are further blessed with the fact that our classification system in the Patent Office is a single integrated complete classification, following a uniform plan that may be easily learned and that can be used with less effort and greater assurance than plans which vary from subject to subject. We do deplore, as every scientist and every worker employed with scientific or technical material must, the fact that there is not in existence some universal complete classification which would serve all of our purposes and serve them well.

And now for a confession of such shortcomings as we realize are present in our Patent Office classification work. In the first place, our work is not current. We have less than 15 professional men engaged in classification work at the present time, when to do a thorough job would require at least 100. We hope to procure 100 next year.

As I have indicated, many of our classes, such as the radio art, have not been reclassified for so long a time that the material is in a hopeless and deplorable state. Many industries I am sure have a better classified set of patents in particular fields than we have. We hope that as the problems in classification respond to the greater man power which we are able to direct to that work, we shall have the continuing interest and aid of those men and those industries which have done work in the fields in which we are operating.

While the titles and definitions of our classes are, I think, excellent, the titles of the individual patent documents are frequently entirely unrevealing and sometimes, in fact, confusing. We can do a great deal in the improvement of our titles.

Our alphabetical index to the Patent Office classification is wholly inadequate at the present time, but its inadequacies will also yield to additional personnel and effort.

We have one final problem in which you can be helpful. The patent document as now drawn is not an example of lucidity or good expository composition. As Dr. Weidlein, himself a distinguished chemist, has put it:

> A major criticism directed at the published patent disclosure by scientific men is that legalistic phraseology seems to obscure rather than reveal the real meat of the invention. The deficiencies of prior art practices are usually detailed at length; the advantages of the "instant invention" are all too frequently magnified out of all proportion to its genuine technological value. As a result, the unprejudiced follower of its teaching may (and usually does) experience disappointment when he finds the new invention is by no means the ultimate successful answer it purports to be. It may (and usually does) represent a distinct forward step in the art, but seldom indeed is it more than an "improvement." The law provides for patents on improvements; the layman chemist is, however, insufficiently familiar with statutory patent law to take this into account.
>
> Accordingly, a more conservative presentation and accurate delineation of the results obtained and of the necessary operating conditions—maximum and minimum temperatures, pressures, concentrations, et cetera—will go far to removing all stigma from the patent disclosure, and insure its rightful inclusion in the body of scientific literature.

You can be of help to us by assuring yourselves that any patent application drafted, in which you have any interest as an author or reviewer, clearly and concisely discloses what the invention is. The technical draftsmanship of the claims can be left to others. The disclosure should be clear, succinct, and readily comprehensible. You will thus write a better patent literature, we shall find it easier to use in our labor of classification, and the Patent System will be cleared of one of the major criticisms which has been directed at it.

Wartime Scientific Periodicals[1]

E. J. CRANE

Ohio State University, Columbus, Ohio

A JOURNAL file lacks a good deal in value if it is not complete. Too often the missing numbers are the ones wanted for use. In normal times the maintenance of complete library files is a matter of vigilance and care, but not of great difficulty; in times of world-wide war the difficulties increase enormously. What happened to the scientific and technical periodicals of the countries affected by World War II? What effect did the war have on their international distribution? And what are the prospects for chemists who may wish to consult papers in wartime numbers of German and other oversea periodicals?

World War II lasted approximately five years. During the first four of these years scientific publication in the countries directly affected by the war in general diminished gradually, but kept up surprisingly well in consideration of the difficulties. More than half of the papers abstracted in *Chemical Abstracts* during a normal year have been coming from Europe, and yet down to the end of 1944 world-wide publication in chemistry, as reflected by the number of abstracts in *Chemical Abstracts*, was down only about one-third from the prewar level. The drop was probably not quite that much, for *Chemical Abstracts*, even though it managed reasonably well currently to cover the wartime chemical literature, missed enough papers to make it a short measure of drop in publication. The really big breakdowns in scientific publication occurred during the last year of the war. In the defeated countries there has been little or no revival thus far.

Preoccupation of scientists with wartime work which was not for publication and diminishing supplies of paper were the principal factors in the decrease in publication. The paper situation affected sizes of editions, sizes of pages, and the number of pages turned out. Formerly fat journals gradually grew slender or appeared as combination numbers, but except for the publications of the defeated countries most of the well-established journals kept alive through the war years, and even those of the defeated countries kept going during the greater part of the war. Suspended periodicals, except in Germany and Japan, are coming to life again in most instances.

I shall discuss chemical periodical publication briefly by countries.

At the beginning of World War II Germany was turning out about 19 per cent of the world's output of chemical papers and was second only to the United States, which was producing approximately 28 per cent. The German journals carried on with very little shrinkage for a number of months after the war started. Gradually they dropped in size and quality of paper, but, everything considered, continued to be rather surprisingly active during the first three and a half years of the war. In April, 1943, by government order, many combinations of German journals were made. If two or more journals were serving a given branch of chemistry or industry, as the fuel industry, these, for the most part, were combined to continue as a single journal labeled as a combination. Then, late in 1944, publication in Germany was stopped almost entirely, again by government order. A good many chemists have visited Germany during the postwar period. Most of those whom I have consulted think that Germany will eventually come back in the publication of science and technology, but not rapidly as happened after World War I. There are many serious obstacles, but publishers and book dealers are being screened with a view to the extending of licenses for the renewal of business, and several German publishers are said to be making plans.[2] Except for two or three medical journals and a few other publications necessary for everyday use nothing was appearing at the beginning of 1946. A new journal, *Zeitschrift für Naturforschung*, appeared early in 1946,[3] but conditions are not good for the early revival of the well-known German scientific journals.

Japan, another defeated country, was turning out about 4.5 per cent of the chemical papers published in 1939. Communication with Japan has been particularly difficult. I have been told that the Japanese scientific journals continued to appear during the greater part of the war period, but are discontinued now. *Chemical Abstracts*, even with government aid, has been unable to get the wartime numbers of Japanese scientific journals. It is said that no one in this country has succeeded in getting these numbers. Some abstracts are now being made in Japan for *Chemical Abstracts*.

Italy, German ally under Mussolini and producer of about 3 per cent of the chemical papers in prewar days, fared badly during the war as a chemical publisher and is pretty much out of the picture at the present time. One of our abstractors in Italy, who at considerable risk kept up with his work for *Chemical Abstracts* throughout the war period, has reported that in his country, "scientific and technical work was remarkably reduced during the war and became practically nothing at the end of 1943 with the German occupation." During the last 18 months of the German phase of the war publication was definitely suspended in occupied Italy by German order.

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8–12, 1946.

[2] *Cf.* ADAMS, R., *Chem. Eng. News*, **24**, 454 (1946).

[3] *Chem. Eng. News*, **24**, 790–2 (1946).

Revival in chemical publication has occurred in a small way. Reale accademia d'Italia and its publications were suppressed, but the important *Gazzetta chimica italiana* appeared down to 1944.

In 1939 approximately 14 per cent of the published chemical papers were appearing in the British Empire. This has been true every year a count has been run. The British reputation for stability has been maintained in remarkable degree through the years as far as chemical publication is concerned, the curve representing percentage productivity being approximately a horizontal straight line. Paper shortage became a severe limiting factor in England as the war progressed, but the British scientific journals lived, and the quality of information published remained good. A good many numbers of British journals destined for this country were lost in ship sinkings. Editions were usually too small for replacements.

Russia has become an important factor in scientific publication. She was turning out about 11 per cent of the abstracted chemical papers in 1939 after a steep climb from about 3.5 per cent in 1929. While publication was sometimes irregular and was a good deal reduced during the war years, the principal Russian journals of interest to the chemist survived and are thriving now. It is often difficult to get Russian periodicals even in normal times. Editions are small, often too small to take care of the needs within Russia, so that numbers available for export are limited or nonexistent. One important American book dealer reports not being able to obtain a single Russian volume published earlier than 1943. *Chemical Abstracts* has been able to get the principal Russian publications, both during the war years and thereafter, by the exchange route. The publications of the American Chemical Society are apparently held in high regard in Russia, and they constitute good bartering material. Special efforts are being made to get more Russian publications for use in this country, including wartime copies. A government agent is in Russia for this purpose, and other organized efforts are under way. It may be necessary to resort to photocopying, probably in microfilm form.

Hard pressed though she was, France continued to publish her scientific journals in many instances throughout the war period. Paris was not destroyed. Those journals which were discontinued during the war have, for the most part, started up again. New journals are appearing. The French output in 1939 was approximately 9 per cent. The journals which appeared during the war years were often very thin. We have been quite successful in getting copies of French wartime numbers of journals, and I believe that American libraries are being pretty well replenished with these.

Publication in Switzerland continued unabated during the war years. The important *Helvetica Chimica Acta* has become one of the leading chemical journals of the world. Copies of this and of other Swiss journals have been scarce in this country during the war years, but *Chemical Abstracts* got them and others are succeeding in getting copies.

In another neutral European country, Sweden, publication also thrived during the war years, and postwar deliveries of accumulated Swedish journals to this country have been good. The other Scandinavian countries were, of course, hard hit by the war.

In the low countries, Holland and Belgium, a good deal of publication went forward during the time of war and again publications, as the important *Recueil des travaux chimiques des Pays-Bas*, uninterrupted in volume numbers, are reaching this country.

Poland and Czechoslovakia were particularly hard hit by the war and were, it is thought, knocked almost completely out of the publication picture during the war years, but the important *Przemysl Chemiczny* is starting up again and so are some of the Czechoslovakian journals.

In China, at war during so many years, chemical publication managed to survive in part. About half of the 20 Chinese publications of chemical interest have continued in some form or other during the war. The *Journal of the Chinese Chemical Society* changed from a monthly to a half-yearly publication, but scientific research and its recording did continue in the unoccupied areas of China throughout the long war years. China has a good deal of resiliency and vitality, but it is predicted that the return to the prewar level of publication will be slow, inasmuch as the laboratories and research centers which were temporarily removed to west China are now in the process of moving back to the eastern coastal areas.

Scientific publication in Spain, Mexico, and the South American countries, never very extensive, was, in general, not seriously affected by the war. It is growing.

In the United States chemical publication fell off after 1941 as a result of our entry into the war, the drop being roughly estimated at about one-third. There was an occasional change in frequency of appearance of journals, as the change from a semimonthly to a monthly journal by the publishers of *Physical Review*. Editions were held to a minimum by the paper shortage, and there were many changes in format, paper weight, and size of type for this same reason. Libraries, particularly those overseas and new ones to be created, will encounter difficulties in getting even United States periodicals in complete supply for the war years.

Distribution of periodicals was affected by the war even more than their production. The flow was stopped in many instances by blockades, by censorship rulings, and by other interfering wartime measures. Librarians had to decide whether to make an effort to get periodicals during the war years when these came from overseas and thus to take care of current needs, or to have these stored for postwar delivery and thus to attempt to safeguard eventual completeness of files. Either decision had its drawbacks, for those who tried to maintain current files failed in a good many spots and those who had journals stored sometimes lost them as a result of bombings, fires, theft, vandalism, and the like, in addition to lost use during war years of numbers eventually obtained.

Some journals were stored by the issuing institutions and others were stored by book dealers. The periodicals stored in France and certain other countries are coming through pretty well now, but not so those stored in Germany. A large collection is in Russian-held territory.

A great many of the more important European scientific journals were made available for use in this country in one form or another during the war years. During the earlier months of the war, after the British blockade was established, *Chemical Abstracts* got a good many copies of journals by having them sent by direct mail down through Italy since the Italian ships were not being stopped. Then when Italy entered the war there was a period during which we had German periodicals mailed so as to go across Siberia and thus to escape the blockade. Of course, the German attack on Russia stopped this.

During a portion of the earlier part of the war a committee of the American Library Associations, headed by Thomas P. Fleming (it was called the Joint Committee on Importations), brought into this country, with government aid, some large shipments of European journals. These were distributed carefully to provide maximum usefulness. *Chemical Abstracts* was permitted to purchase over $2000 worth.

Somewhat later in the war period, as things got tougher, German periodicals as well as those from the German-occupied countries were brought to this country only in single copies in microfilm form as a government program. *Chemical Abstracts* has many of these.

Soon there developed a very important program which I think was a significant factor in the prosecution of the war. The Alien Property Custodian obtained single copies of many important European periodicals and had these reproduced by offset printing for distribution to all American institutions or individuals who wished to subscribe. Eventually 3200 issues of 116 periodicals were thus reproduced. That the chemists fared well is evidenced by the fact that of the 116 periodicals thus reproduced, 41 per cent are devoted almost exclusively to chemical subjects, 26 per cent are devoted very largely to papers of chemical interest, 25 per cent are of some chemical interest, and only 8 per cent are completely outside the range of chemical interest. This program of the Alien Property Custodian was discontinued in October, 1945, but the Custodian is helping private agencies to continue in this kind of work by vesting publications. The Custodian will assist as long as peace is not officially proclaimed. On March 22, 1946, Alien Property Custodian James E. Markham seized existing copyright interests in all German publications issued from 1939 to 1945.

With the guidance, advice, and encouragement of the Association of Research Libraries and others, J. W. Edwards, Publisher, of Ann Arbor, Michigan, is carrying forward and expanding the periodical republication program of the Office of the Alien Property Custodian. The program of expansion is to be confined to journals of German origin. This organization is prepared to consider the reproduction of at least 500 additional German scientific and technical periodicals if the demand warrants. These journals are to be reproduced either in facsimile or in miniature. This program is mentioned as a promising means of filling the gaps in library files left by the exigencies of war. It is said that the cost will not be greater than direct subscription would have been.

Miniature offset printing, a compromise between photoprinting and microfilm copying, is experimental but promising. The type can be read with the naked eye, more easily with the aid of a low-power hand-glass.

Microfilms, Inc., of Ann Arbor, Michigan, has been helpful in many cases in providing copies of needed papers published during the war in countries affected by the war.

It has been mentioned that *Chemical Abstracts*, with good help, managed to cover the wartime literature with reasonable completeness and promptness. The methods used have been described elsewhere.[4] Reasonable completeness is not enough. Papers missed during the war years are being picked up and abstracted now as this becomes possible. Mention of this is made here in a paper principally devoted to a discussion of journals containing original papers instead of abstracts because, with the American Chemical Society's new photocopy-service,[5] there is a relation to the problem of getting wartime papers for individual use at least. The first step in getting a paper is learning about it. The American Chemical Society's photocopying service applies to papers locatable any place in the United States. In view of the wartime irregularities in journal files in libraries this newly arranged service is timely and should be an important factor in keeping a bridge over the gap between abstracts and original papers in spite of all of the havoc in libraries made by the flood of war.

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[4] *Chem. Eng. News*, **23**, 1757–8 (1945).
[5] *Chem. Eng. News*, **24**, 14 (1946); *Chem. Abstracts*, **40**, No. 1, p. i–ii (1946).

Searching the Russian Technical Literature[1]

J. G. TOLPIN

Universal Oil Products Company, Chicago, Illinois

AS ONE of the outcomes of World War II, Russian science has more significance for us than ever before, and only now does it become clearly apparent to everybody concerned that we do not have adequate sources of information about it. Therefore, a discussion of the present state of the Russian scientific literature seems timely, especially the chemical literature, of certain trends in its development, and of some methods suitable for finding in this literature as much information as is possible under the prevailing conditions, which are in a measure unfavorable to such an effort.

Having discovered the existence of an industry in the U. S. S. R. powerful enough to support an unprecedented war effort, the American chemist is beginning to change his attitude toward Russian research and scientific publications. In the recent past some rejected the Russian chemical literature altogether, as containing no significant or original information; others took an opposite view, while a third group realistically expected that among the large numbers of research workers drawn into the many chemical institutes in Russia, there would undoubtedly be a certain percentage of capable men gifted with imagination who would produce important data.

Thus, whereas only a small number of chemists and chemical bibliographers in this country were willing to contend with the difficulties encountered in attempting to cover the Russian scientific literature, this number has grown now to important proportions. Recent surveys (*4*, *14*) showed that many American universities are now offering courses in Russian. The demand for translation of chemical articles from Russian is generally increasing. The American chemist who is now coming in closer contact with the Russian chemical literature wants to know how best to handle it in order to find there the information of value to him.

The state of the Russian chemical literature is, naturally, a reflection of the development of the chemical industry. There is no adequate basis for judging the state of the Russian chemical industry at the present moment. Its personnel included 1000 chemists in 1913 (the membership of the Russian Chemical Society was only 514 in 1914); in 1925 the chemical industry of the U. S. S. R. employed 2000 technologists. In 1937 this number rose to 32,000 (*17*). In 1941 there were 50,000 chemists in the U. S. S. R. The number of research institutes serving the chemical industry was 40 in that year. I do not know exactly how many research institutes there are in the U. S. S. R. now. Recent information (*5*) indicates that the number of all schools for higher education (including technical schools), which decreased under the impact of German invasion, is, in the school year 1945–1946, 772, almost as many as in 1940. The aim of the present plan is to attain in 1950 a total of 150,000 college graduates per year.

The numerous young chemists who joined the ranks of their older colleagues in Russia started to work under a tremendous strain. Their work was geared to a slogan "to reach and overtake the industrially-most-advanced countries of the world." On the other hand old standards of education were shattered and new ones were only being created; there was no time for gradual growth, learning, and making full use of the chemical traditions of the past. The bibliographical services, the writers on chemistry, editors of chemical publications, proofreaders, even printing facilities—all these were available in numbers far below those required for the desired rapid expansion. One should reckon with these conditions in searching the Russian technical literature of recent years.

The Russian technical literature grew rapidly, and there appeared in Russia in 1938 up to 200 periodical publications devoted to chemistry and over 300 nonperiodical chemical bulletins and reports (*17*). For many of these subscription was solicited abroad, and in 1939 the total number of Russian technical periodicals for which subscription was accepted in this country exceeded 300. The 1946 list of journals open to subscription in the U. S. A. includes 103 periodicals in the sciences and related fields.

For the purpose of comparison the Russian chemical publications may be divided roughly into the following groups: (*a*) those published directly under the auspices of the Soviet Academy of Sciences; (*b*) those published by various other organizations, such as the State Scientific-Technical Publishing House (GONTI) and carrying material of applied nature; (*c*) periodical and nonperiodical proceedings and reports of various institutes, schools, and experimental plants; and (*d*) literature intended primarily for the junior personnel, graduates of *technicums* (secondary technical schools), foremen. Novel principles are not published in the last-mentioned type of periodical, but practical instructions told in simple language.

If we had in our libraries all the Russian technical publications, we could probably gain a rounded picture of the scientific developments pursued by Russian scientists from the first two categories of this literature, since the attitude of the Russian scientist is to report his data freely and fully as soon as he can. Unfortunately, however, we are as a rule seriously hampered by the deficiency of Russian scientific material in this country. While some lines of research are well repre-

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8–12, 1946.

sented in what literature we have in the country, on others we have but fragmentary information. This situation exists also with respect to other sciences (*11*), as well as the humanities. This was established by surveys of the Library of Congress (*3*). The reason for the deficiency of Russian publications dealing with applied sciences differs, however, from those responsible for the lack of published information in other fields. A partial solution of this problem could be achieved by a well organized exchange of the Russian chemical literature held in American libraries.

Since 1939 a new trend has gradually made its appearance. A number of journals, notably those falling into the categories (*b*) and (*c*) above and reporting on the application of the results of scientific research in industry, are no longer available to would-be subscribers outside of the U. S. S. R. This is apparently due not alone to shortages of paper and printing facilities, but is a part of the paramount world problem of today, the problem of war and peace and cooperation between nations. Even technical books released for shipment outside the U. S. S. R. are very often unobtainable, for the quota of copies to be sold abroad is too small to fill all the orders from this country.

The situation is aggravated by the fact that the data reported in these publications are apparently freely available to Russian readers and are quoted in that part of the scientific literature which we do receive in this country. Consequently, they are considered published information and bear on the patentability of some American inventions in the fields to which they relate. If this is coupled with the expected release of information on the wartime researches, the situation will be seen definitely to require remedying. Throughout the war years I came across mention of significant technological developments in the U. S. S. R., details of which were obviously withheld from publication. I am happy to mention in this connection the initiative taken by the Chicago Section of the American Chemical Society in an attempt to provide American chemists with this missing literature. Let us hope for success in that undertaking. In other fields similar attempts are being made in this country (*3*, *11*).

Until a unified central source of information about the published results of chemical research in the U. S. S. R. is available, the American chemist will be handicapped by the difficulties encountered in attempting to find out (1) whether a line of research of interest to him is being pursued anywhere in the U. S. S. R., (2) if this is the case, whether data have already been published bearing on his research or on the patentability of his claims, and (3) how to obtain the complete pertinent information published in the Russian language on the subjects of interest to him. Circuitous methods must be resorted to in attempting to answer the first two questions. Unfortunately there is no way of satisfactorily answering the third, for the reasons discussed above. Even some of the Russian bibliographical publications mentioned below are very scarce and in part unavailable in this country at the present time.

When an American chemist intends to make a literature search, he starts with *Chemical Abstracts*. When a Russian chemist is in a similar position, he may be obliged to start with . . . *Chemical Abstracts*. I am not sure that all American chemists appreciate the completeness of our bibliographical publications and the services of our libraries. The Russian bibliographical journals and abstract sections of chemical and engineering journals are very useful, but none of them attempts to present a complete record of the chemical literature of the world. The abstract journals, including *Khimicheskiĭ Referativnyĭ Zhurnal* (*Chemical Abstracts*) and *Fiziko-Matematicheskiĭ Referativnyĭ Zhurnal* (*Physical and Mathematical Abstracts*), will probably be restored after a wartime interruption. These journals, and also *Tsentral'nyĭ Meditsinskiĭ Referativnyĭ Zhurnal* (*Medical Abstracts*), cover their research fields as far as Russian publications are concerned. Since many of the original Russian articles never reached us, their abstracts are the only source of information of their contents. No abstracts of non-Russian articles appear in the above journals; however, there are some journals which carry abstracts of Russian and non-Russian material. Of these, *Novosti Tekhniki* (*Technical News*), published by the Institute of Technical and Economical Information of the U. S. S. R. State Planning Organization, may be mentioned. Chemical and engineering journals, such as *Khimicheskaya Promyshlennost'* (*Chemical Industry*) and *Promyshlennost' Organicheskoĭ Khimii* (*Organic Chemical Industry*), have their own abstracting sections, but they are limited in many cases to abstracts of non-Russian papers.

Since the different organizations within a single industry in the U. S. S. R. freely exchange information and their management is unified, their bibliographical services extend throughout the entire branch of the industry in question. This is comparable to an information service within an American company, but extended to cover an entire industry. It is done by printing abstracts on cards and distributing lists of cards or the cards themselves, arranged topically or in some other manner. Some industries in the U. S. S. R. publish abstracting journals covering their fields. The publication *Novosti Neftepererabotki* (*Oil Refining News*) has carried many advance abstracts of reports which subsequently appeared in complete form in the Russian petroleum journals. However, these bibliographical services are in most cases available to Soviet industrial organizations only and are not distributed on subscription outside the country.

Transactions of research institutes and of plant research laboratories are also printed primarily for the purpose of supplying information to the colleagues of the authors within the same industry. They receive mention in news reviews published in the chemical journals and journals on science published for the lay public under the auspices of the Academy of Sciences of the U. S. S. R., such as *Vestnik Akademii Nauk S. S. S. R.* (*Bulletin of the Academy of Sciences U. S. S. R.*),

Priroda (*Nature*), etc. It is thus of interest to follow these journals if one is to keep informed of the type of research in progress in the U. S. S. R.

If a line of research is developed to the point of its industrial use, handbooks, directions for the plant personnel, etc., may be published, and these, similarly to various transactions of research institutes, will receive mention in the bibliographical publications. One important source of this information comprises *Knizhnaya Letopis'* (*Book Chronicle*) and *Letopis' Zhurnal'nykh Statei* (*Chronicle of Journal Articles*). I do not know the present state of publication of these two weekly periodicals, which were in 1941 in the 35th and 16th year of their existence, respectively, but undoubtedly their publication will be continued or even expanded. The second of the two, listing magazine articles, resumed publication in 1945. I have found in *Knizhnaya Letopis'* reference to publications not available in this country to my knowledge, at least not recorded in abstracting journals and library catalogs. While these publications attempt to cover their two parts of the entire Russian bibliographical field, they have several sections of interest to us, such as those under the headings industry, technical sciences, agriculture, transportation, aviation, medicine, natural sciences, mathematics, geography.

The above sources may be enough to indicate only the existence of research data, but not their nature. A glimpse of the claims made as to the outcome of that research is provided by the nontechnical discussion given in Russian technical articles and books, as well as by the semiscientific literature. A complete picture can never be obtained by these means, however. There is no strict separation of the type of material carried by the different standard technical journals from that appearing in publications of limited circulation, such as progress reports, bulletins of experimental plants, etc. An author will sometimes refer to data obtained by an analytical method previously published in an obscure and unavailable periodical. Sometimes even a previous installment of a series of articles will be unavailable for a similar reason.

Description of previous Russian research work in a given field referred to in current articles should be sought in the review literature, including monographs and handbooks. This material should be used with discrimination in order to distinguish clearly between the Russian and non-Russian work described. Of particular interest are Russian books reviewing some fields of science or technology in which the Russians have made many contributions. These books are, as a rule, reviewed in the regular scientific and bibliographical journals and may deal either with work peculiar to the U. S. S. R.—for example, the composition of the oils from U. S. S. R. fields (*15*)—or with problems of more general interest. As examples of this type of monograph, recently published books on gas producer automobile engines (*9*), on the biochemical and physiological principles of grain storage (*7*), on application of thermal analysis in chemistry (*2*), and on the viscosity of liquids and colloid solutions (*12*) may be mentioned. In this category also belong review articles published in the journals, such as *Uspekhi Khimii* (*Progress of Chemistry*), *Uspekhi Fizicheskikh Nauk* (*Progress of Physical Sciences*), and *Uspekhi Sovremennoĭ Biologii* (*Progress of Contemporary Biology*). Articles in *Tekhnicheskaya Entsiklopediya* (*Technical Encyclopedia*), *Fizicheskiĭ Slovar'* (*Dictionary on Physics*), and similar compendia are also helpful in this connection, either by themselves or by providing references to fuller description of older Russian work in the field reviewed.

Concerning methods of obtaining the detailed data of Russian chemical research, this is possible without much difficulty in many cases. A good many chemical research organizations in the U. S. S. R. consistently publish their current reports in one of the journals normally available in this country, at least that part of it that may be classified as strictly scientific knowledge. Our bibliographical journals, especially if supplemented by Russian review journals, may be a sufficient guide to this material.

In many other cases, however, the original Russian material available to us is incomplete. If summarized in book form, it may lack some details of interest to an American reader. It is sufficient to read correspondence from the U. S. S. R. in the lay press of this country to become aware of the fact that in many scientific endeavors the Russians have developments in which our chemical industry may be interested to a larger or smaller degree, but which in any case merit detailed reporting. American scientists who visited Russia recently confirm this impression (*8*). The lists of Stalin prizes issued annually during the last five years refer to important researches in pure and applied chemistry, on some of which we have very little information. I personally receive inquiries about some of these developments which have, in many cases, not been described in detail in the Russian scientific literature available to me. An attempt to report them fully can rarely be successful with the scarcity of that literature existing in the United States now. It should also be noted that we do not have, to my knowledge, anywhere in the country the recent Russian patents in their complete form, and the sets of patent abstracts available have gaps.

Having stressed the necessity of following the Russian technical literature, let us mention here certain of its peculiarities and also some criticisms which are occasionally made in this country. This is not intended as a reproach to anybody, but rather as a warning to the American chemist who only now comes in contact with the Russian technical publications not to become discouraged, for it is believed that the results will justify his effort.

Despite the more or less unified management of scientific publications in the U. S. S. R. and the great influence exerted by the Academy of Sciences there in all matters of scientific development, including publication activities throughout the country, differences in the manner of writing and editing are observed, obviously resulting from the exceedingly rapid growth after

the revolution and a variety of other influences. Some features of the Russian technical literature were discussed in the author's previous papers (*13*).

The prerevolutionary chemical literature is a record of the work of chemists thoughtfully working without too much haste on problems of large chemical significance, but in the main detached from industrial connections; for the chemical industry of Russia was very small before the industrialization drive began in 1928. The Russian technical literature of recent times still bears the earmarks of the turbulent years of revolution, preparedness for war, and war itself.

With passing of time after the revolution, the influence of the older Russian scientific literature on the present-day Russian chemical reporting is again being felt; 220 years of scientific activity brought out a number of traditions in Russian writing on science which will continue to be a strong factor in this field.

The Russian chemist had in the past a closer tie to the German chemist than to chemists of other countries, although in recent years the reference to American chemical publications is consistently increasing in the Russian chemical literature. An analysis of the references to journal articles, books, and patents used in 1939 by the authors publishing in *Zhurnal Obshcheĭ Khimii* (*Journal of General Chemistry*) gives German references a better than 2:1 numerical superiority over English-language references (*10*). French references were considerably fewer.

As a rule articles in the journals published directly by the Academy of Sciences are concise, stress the scientific principles involved in the work under report, and are well edited. The non-Russian editions of journals published also in Russian are frequently better printed, on better paper, and in a better type than the Russian editions.

With respect to the other publications, it is apparent that the referee system and other forms of supervision of writing and publication of scientific data known to the American writer on science do not similarly operate in the U. S. S. R. This may be responsible for the spottiness of some published Russian research. Cases have occurred in which a principle was tested only on some representatives of a series of compounds, although good results could be expected from some other members of the same series as well.

The diversification of American technical publications is not present in Russia either. In consequence of this some Russian journals carry well written articles reporting important research alongside other articles which would receive considerably less space in an American journal of comparable type or followed by articles reporting research nearly bordering on routine work. Let it be emphasized that it is the strictly scientific American publications to which we refer here. Among the conditions peculiar to Russian publication activities is extinction of what is known in this country as a "trade journal." Some material which is normally found in trade journals is, accordingly, incorporated in articles appearing in Russian scientific journals. The purpose of this material may be to claim credit for a new development, to project the significance of this development on the background of the general growth of industry in the U. S. S. R., or to report new advances in a branch of science throughout the world.

A tiresome thing to an American scientist is the long introductory discussion given with some articles, usually a review of the literature or a recapitulation of the author's previous work. Material of this type may serve as a review for a Russian beginner in the field, and occasionally it supplies a non-Russian reader with interesting information on previous Russian researches on the subject printed in publications unavailable to him.

Occasionally American readers are impressed by an insufficient proportion of experimental data relating to the different parts of the research reported, in comparison with the relative significance of these parts. One would sometimes like to see some conclusions supported by more data, while on other points the tabulated and graphical data given may be overabundant.

Points of criticism of lesser importance concern themselves with errors in literature references and transliteration of non-Russian names. Some Russian journals are now publishing non-Russian names in the Latin script.

The difficulties discussed are not insurmountable, and one should also bear in mind that they are temporary.

There are various indications that the Russian scientist is much interested in the reaction of his colleagues abroad to his work. This is the reason why some science journals are published in non-Russian languages in the U. S. S. R. At the recent celebration of the 220th anniversary of the Soviet Academy of Sciences, the aim to cooperate with non-Russian scientists was stressed by responsible leaders of the Academy. The desire for recognition has an increasing effect on the general policy of the Soviet scientific institutions, as evidenced in a number of reviews of contemporary scientific developments in the U. S. S. R. and also in the announced creation of a special Institute of the History of Science (*6*). This institute is going to publish a number of works, among which are "History of Russian Natural Sciences," "Outstanding Leaders of Russian Science," and "Great Contributors to Russian Science." A Committee on the History of Technology, headed by B. N. Yur'ev, has also been active since 1942 in the Academy of Sciences of the U. S. S. R.; this committee has published three histories of technology in the U. S. S. R. and has in preparation more historical works of a similar nature (*1a*). The recent tendency toward nationalism which expresses itself in stressing the role of the Russian scientist of prerevolutionary times is noteworthy.

It is likely that now that the war is over and peacetime reconstruction of the U. S. S. R. is the major objective of the newly announced five-year plans, an improvement in the publication activity in the U. S. S. R. will be brought about. A start in this direction

is apparently already being made (*16*). The leaders of Soviet science were taking measures to that end also before the outbreak of the war. Since 1933 a committee on technical terminology, which is credited with 60 studies on this subject, has been active within the Academy of Sciences of the U. S. S. R. (*1*); however, during the war publication of many journals was interrupted and others decreased in volume and, to some extent, deteriorated in printing and in proofreading. Not alone is this situation now being ameliorated, but Russian bibliographical journals with a wide scope may also be expected, with the aid of which an American scientist may gain a more satisfactory perspective of the work of his Russian colleague as the Russian chemist has of the work of his American colleague. The Russian scientific activity will henceforth be a potent factor to reckon with, and adaptation to the conditions of the moment in searching the literature and in reporting it is necessary.

LITERATURE CITED

(1) BARDIN, I. P., *Izvest. Akad. Nauk. S. S. S. R.* (*Bull. acad. sci. U. R. S. S.*), 313–4 (1945); *ibid.*, 448–51 (1945); (*a*) *ibid.*, 283, 315 (1945).

(2) BERG, L. G., A. V. NIKOLAEV, AND E. YA. RODE, "Termografiya" ("Thermography"), Academy of Sciences, U. S. S. R., Moscow-Leningrad, **1944.**

(3) CLAPP, V. W., Special Libraries Conference on Russian Materials, American-Russian Institute, New York City, November 17, **1945**, pp. 1–3; YAKOBSON, S. (Library of Congress), Private Communication.

(4) COLEMAN, A. P., *American Slavic and East European Rev.*, **4**, 8–9, 185–208 (1945).

(5) *Information Bull. of the Embassy of the U. S. S. R.*, December 12, **1945**.

(6) KOMAROV, V. L., *Vestnik Akad. Nauk. S. S. S. R.* (*Bull. acad. sci. U. R. S. S.*), 30–3 (1945).

(7) KRETOVICH, V. L., "Fiziologobiokhimicheskie osnovy khraneniya zerna" ("Physiological and Biochemical Principles of Grain Storage"), Academy of Sciences, U. S. S. R., Moscow-Leningrad, **1945.**

(8) LANGMUIR, I., *Chem. Eng. News*, **24**, 759–65 (1946).

(9) PANYUTIN, K. A., "Gazogeneratornye avtomobili GAZ-42 i ZIS-21" ("Gas Generator Automobiles GAZ-42 and ZIS-21"), Narkomkhoz, Moscow-Leningrad, **1942.**

(10) PLATE, A. F., *Uspekhi Khim.* (*Progress of Chemistry*), **9**, 589–95 (1940).

(11) SHAPLEY, H., Private Communication; SHAW, R. R., Special Libraries Conference on Russian Materials, American-Russian Institute, New York City, November 17, **1945**, pp. 18–9; see also JONAH, D. A., *ibid.*, pp. 7–10.

(12) "Soveshchanie po vyazkosti zhidkostei i kolloidnykh rastvorov" ("Conference on the Viscosity of Liquids and Colloidal Solutions"), Institute of Machine Building, Moscow-Leningrad, May 12–16, **1941. 1941** (Vol. I) and **1944** (Vol. II).

(13) TOLPIN, J. G., J. CHEM. EDUC., **21**, 336–42 (1944); *ibid.*, **23**, 123–6 (1946).

(14) TOLPIN, J. G., *Science*, **103**, 86 (1946).

(15) VELIKOVSKII, A. S., "Sovetskie nefti" ("Soviet Oils"), GONTI, Moscow-Leningrad, **1938.**

(16) VOL'FKOVICH, S. I., *Izvest. Akad. Nauk. S. S. S. R.* (*Bull. acad. sci. U. R. S. S.*), 80–4 (1945); YAKUBOV, S. F., 447–8 (1945).

(17) ZASLAVSKII, I. I., *Uspekhi Khim.* (*Progress of Chemistry*), **13**, 328–35 (1944).

Foreign Technical Publications[1]

FLORENCE HARDEN

Lansdowne, Pennsylvania

THE publications of national governments in the field of chemistry are important media for the exchange of scientific information. Government research is concerned more with the welfare of a country and of its people than of one branch of an industry and is geared to subjects of particular geographical significance. The publications recording this work contain information, which, when directed into various channels, can contribute to research that is being done both publicly and privately. For instance, the Commonwealth of Australia has spent a considerable sum on research in methods of treating certain diseases of sheep. The findings are reported in Australian government publications. This information can be used by chemists, working in governmental or in private industrial research, in the United States or in England or anywhere that sheep fall prey to the diseases discussed. It can be employed by veterinarians who treat these diseases and who experiment in the field with the findings of research chemists. Because governments can marshal all forces, both public and private, as needed, because their chief concern is the public good, and because financial returns are not dominant in consideration, they can undertake research that is costly but of far-reaching value.

Geographical boundaries have never been the province of science. While at times political and social upheavals have caused these boundaries to become walls of official scientific silence, the cessation of exchange of information has been brief and limited. The recent conflict has proved this point. Throughout the period of hostilities in Europe a steady flow of scientific publications came from enemy countries. The interest in these works was sufficient to warrant the duplication and issue of them by the Alien Property Custodian. Even though no official mention of the existence of this material was given, it was a part of world scientific knowledge that was being exchanged even during war. Science has used the work of a Swedish chemist to assist the United States in creating the atomic bomb; it has used the discovery of penicillin by an Englishman with American knowledge of mass production methods to

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8–12, 1946.

save the lives of peoples of all countries. Science has developed a practical internationalism.

Scientific information that is exchanged among countries falls into two categories—that produced by scientific organizations and other private bodies, and that issued by government agencies. The scientific journals issued privately enjoy wide circulation in all countries and are the best known of international publications; however, the government publications are an important part of scientific literature. The importance of the publications of the United States government in the chemical field is being realized more completely.[2,3] There is a need for a realization of and a use of the publications of the governments of all countries as sources of scientific information.

In any brief discussion of the publication of the results of research only a glimpse into a vast field of potential information can be given. This is as true of government documents as any other type of printed data. Specific titles of all issues would require a lengthy dissertation and, at the present time, would not be of practical value because some of them could only be obtained in the country of origin. So the titles that are mentioned are to be considered as illustrative and indicative of what has been done in the past, what is being done now, and what may be expected to be done in the future.

The general subjects that have been chosen for discussion are (1) the types of publications issued by governments other than the United States that are of interest to the chemical industry; (2) the methods by which these publications are indexed; and (3) the methods by which, or the places where, these publications may be obtained or consulted. Another part of the paper will deal with publications and agencies that provide trade and market information of value to the chemical industry.

Within the subject boundaries that have been set up, certain limitations in regard to countries to be included have been imposed. These limitations have been necessary because many of the foreign centers of information in this country are just organizing their collections of federal publications. Gaps have been left by the war in publications received in this country and an adequate exchange system has not been developed. So with due consideration for the importance of pertinent and timely information, the following arbitrary limits have been set up within the subjects covered: (1) the publications of only those countries have been considered from which it was possible to obtain information or see the publications at the embassies, New York City consulates, offices of information, or trade information centers in this country. In some cases information was obtained through these channels directly from the country; (2) journals included are obtainable in libraries in United States; (3) trade information supplied by foreign chambers of commerce and trade information centers, whether a part of the government or not, has been covered because of its present importance to the expanding chemical import and export business; and (4) patent information has been omitted for the present.

Generalities are dangerous in so wide a field as international scientific government documents. Yet an analysis of them indicates that usually they fall into these classifications: (1) indexes, lists, and bibliographies of all government publications; (2) indexes and lists of the publications of individual bureaus and departments; (3) technical bulletins and pamphlets issued by various departments; (4) technical journals; (5) annual reports; and (6) special issues. The coverage and the arrangement of these classes of publications varies; however, the type of content usually falls into one of these categories.

The indexes, lists, and bibliographies of all government publications are invaluable in locating all publications on a given subject, regardless of its source of issue. While the lack of subject indexes to these lists makes an examination of the entire contents mandatory, the name of a bureau or of a department usually indicates type of issue. For instance, in general the Council for Scientific and Industrial Research of Australia would be the source of information on most branches of the chemical industry. It covers such topics as national standards, lubricants and bearings, dairy research, radio research, mineral utilization, chemical engineering, plant and pasture investigation, and aeronautical studies; however, a publication by the Liquid Fuel Control Board might be important to a chemist investigating the classification of diesel-oil fuel. A composite list of all government publications such as is issued by the National Library of Australia serves as a guide to all government issues. Likewise, the English government issues an annual list of all government publications, since the list of the Chemistry Research Board of the Department of Scientific and Industrial Research would omit such publications, for example, as the special reports of the Medical Research Council, or a pamphlet on television issued by the Science Museum. Departmental arrangement is usually the one of choice in these lists. The composite lists, indexes, and bibliographies of a country's government documents is an important guide to the variety of its research interests and of their practical results in printed form.

In general the lists of publications of the various departments of governments follow the same pattern as the composite lists. The arrangement is chronological according to type of publication rather than subject. The subject arrangement of scientific literature, such as that in the Bibliography of Agriculture issued by the Library of the United States Department of Agriculture and in the List of Publications of that same department, is still unique in the listing of government literature. Chronological arrangement still seems to hold precedence over other methods of listing even though the weaknesses of this method may make much of the material less useful than it should be. The issue of de-

[2] LAWRENCE, R., Information sources for chemical market research running currently in *Chemical Industries*.

[3] HARDEN, F., THIS JOURNAL, 21, 326–32 (1944).

partmental lists is practically universal. They are specialized and fall into such types as annual reports, bulletins, pamphlets, and journals. Each of these types of issue will be discussed later.

Technical bulletins and pamphlets are the outlets for much of the results of research that is of practical interest to the research chemist. It is these publications that record the results of investigations and interpret them or make them ready to be interpreted into practical results. They cover such diverse fields as, in the case of England, aeronautical research and industrial health; in the case of Australia, Kimberly horse sickness, the detonation of nitroglycerin by impact, and ambergris and how to recognize it; in the case of Canada, fisheries research and water resources. Each publication usually treats one subject only. The bulletins and pamphlets in most cases are highly technical and report in detail the results of research undertaken by a government agency on a given topic. Their value is great to the research worker.

Technical journals are a source of continuous reporting of the results of research. They are neither numerous nor well-known among government publications, probably because in many divisions the results of research work are too limited and spasmodic for the publication of a journal; however, some journals are published, and as a group they are highly scientific and a valuable contribution to scientific literature. Among this group of publications is the Chinese *Journal of Industrial Research* which is comparable to our *Journal of the Bureau of Standards*, the British government's *Journal of the Royal Army Veterinary Corps*, and the *Journal of Science and Technology* issued in New Zealand. The technical journals are an important immediate source of scientific material.

Annual reports of government departments are among the neglected sources of valuable information. Usually even in privately printed indexes and abstract journals they are listed simply as reports and their content is lost because their specific subject coverage is neglected. The action of extreme pressure lubricants, experiments on *Clostridium botulinum*, element deficiency in sheep, and the testing of clay were among subjects treated in the 1944 report of the Council for Scientific and Industrial Research of the Commonwealth of Australia. The annual report of Brazil is a unique departure in form and in content from many of its type counterparts. It is divided into such sections as balsams and resins, manganese, and medicinal plants. Each section is illustrated with colored pictures. Full details are given regarding import and export information, as is a description of all natural and manufactured products of the country. Annual reports might well receive more attention by indexers and abstractors as sources of specific information.

Special issues are like miscellaneous files. They provide for all of the publications that fail to fall into the neat, arbitrary blocks that human beings have designated for publications. Yet their existence indicates that research as undertaken by government divisions is in answer to a definite need and does not follow a too sharply defined pattern. Among some of the important special or miscellaneous issues are the *News Bulletin on Plastics* issued by the Sydney Technological Museum, the *Industrial Chemical Circulars* issued by the Council for Scientific and Industrial Research of Australia, and *Mineral Resources of South Africa* issued by the Department of Mines of that country. The special issues are a practical application of the use of government research publications to disseminate all types of pertinent material.

In many foreign countries there are national universities. These institutions frequently issue publications of scientific interest. Among such issues are the reports of the Leningrad Chemical-Technological Institute, the bulletin of the National Academy of Pharmacy of Brazil (*Boletim da academia nacional de farmacia*) and the review of chemical engineering (*Revista de Ingenieria Quimica*) of Chile. Publications of this nature are especially numerous in the Latin American Countries.

The variety of types of government publications makes them a rich source of scientific information. They are varied sufficiently to meet the needs and the interests of the research chemist, the chemical engineer, and the chemical industrialist.

The method of ascertaining what is available in all national government publications is of dominant importance. Unless an adequate index exists, the use of this material will be limited. So far the subject indexing of this type of publication has left much to be desired. *Chemical Abstracts* and *Biological Abstracts* have done a fine job of including abstracts of many foreign government journals and reports and of arranging them under broad subject headings; however, it seems to me that there is a need for an adequate checklist of all available government publications in all countries. All national government agencies should contribute to and have access to this list, and an effort should be made to have this list arranged by subject as well as by country. It would be important to keep the index up to date by frequent supplements. In the final analysis, with a few exceptions, the concern of science is with the results of research, not with the nationality of the worker or the geography of his country. It might help if the international subject checklist of technical government documents included a list of depository libraries and provisions that exist for microfilming and photostating.

A knowledge of the existence of national government documents would have little value unless there were means for procuring them. At present the system of exchange of scientific government publications is not well organized and leaves room for improvement. Humphrey[4] mentions the exchange system between governments as originating in 1886. He states as defects of this system: (1) that they provide for the exchange of single copies only of the specified classes of official publications, an obviously inadequate coverage

[4] HUMPHREY, R. A., "Procurement of Foreign Research Materials," *Dept. of State Bull. No. 14*, January 6 and 13, 1946, pp. 22–5, 34.

when total Federal needs are considered: (2) that they did not cover at all provincial, municipal, professional, and other important private publications; (3) that they specifically did not provide for the initiation of new exchanges, nor for fluid adjustment to changes in departments and ministries; and (4) that they did not constitute suitable sources of bibliographical information even for the classes of official publications covered. He does point out that the State Department through its Publications Procurement Officers is developing a more adequate system for arranging to obtain all necessary publications in sufficient quantity to guarantee their placement where they are most needed.

The majority of the governments of other countries are setting up or already maintain offices of information and boards of trade in New York City. These offices have as a part of their work collecting and making available for consultation all publications of their governments. Many of them hope ultimately to have a service by which they will be prepared to answer technical questions and to lend material to a greater extent than is done now. At present most of these agencies have inadequate collections of printed materials on the chemical industry, but attempts are being made to correct this weakness.

The cessation of the war has opened vast markets to the chemical industry. This is true in regard to world sources of raw materials as well as world markets for finished products. It was decided that the scope of this paper should include trade information that was not strictly government issue. This decision was based on the fact that it was information of great importance to the chemical industry, that much of the basic data was of government origin, and that the results of the study would be of benefit to government bureaus as well as the industrial companies dealing in foreign trade. Consequently the appendix to this paper includes all sources of trade statistics that could be consulted in New York, regardless of whether or not they are the issues of foreign governments.

Many of the governments have set up trade information offices or general offices of information that are designed to assist with all problems of export. Brazil is a case in point; however, in the case of Canada and of Australia the interest of their Offices of Trade Information is directed mainly toward our importing from them rather than the other way around. The work of these organizations is allied closely with that of our Bureau of International Commerce so far as export information goes.

Some countries have chambers of commerce in this country. Russia has such a body, and it issues import and export statistics and occasional reports on the chemical industry. The Swedish Chamber of Commerce of the United States of America issues annual reports and the *American Swedish Monthly*. A bulletin giving import, export, and duty information and lists of trade opportunities is published by the Netherlands Chamber of Commerce. The work of the chambers of commerce is directly aimed at the encouragement of trade between this country and their own foreign countries.

All foreign embassies in this country have a commercial attaché on their staffs. He may have a different title, such as trade commissioner, but he is a representative of his government. He is charged with the responsibility of arranging for imports, exports, agents, and acting in a liaison capacity in trade disputes.

The publication of statistics on the imports and the exports of chemicals is practically universal in all countries. Regardless of whether the publication is that of a government department of commerce, as is true of the Australian Office of Trade Information, or whether it is released through a chamber of commerce, as is true in the case of Russia, the statistics are compiled by government agencies. This material is published annually, and not only gives total imports and exports from each country but also breaks the valuation into commodities. Many of these compilations of trade statistics can be consulted at the United States Department of Commerce in Washington.

Certain publications of organizations not strictly governmental are valuable and should be included in any list of official government documents dealing with trade. The Inter-American Development Commission issues valuable reports on industry and commerce. This Commission is composed of national groups of businessmen who were appointed with the consent of their respective governments. So far pamphlets are available on Mexico, Chile, Argentina, Brazil, and Venezuela. These publications contain much important information on technical standards, transportation, and products of the countries as well as products that are needed.

Some of the miscellaneous issues of governments that are of interest in trade are the *Brazilian Bulletin*, published by the Brazilian Government Trade Bureau and the economic weekly on trade and industrial information that soon is to be released by the Department of Economic Affairs of the Netherlands East Indies Government.

It is probable that an index of government sources of trade and of market information would have real value. Markwood suggested such an idea in regard to United States government publications covering economic releases on chemicals in a paper which he presented before the Chemical Market Research Association. His suggestion was for an abstract service covering chemical statistics. Such a publication might profitably be expanded from national to international scope. Certain it is that a real need exists for the wider and broader use of all trade information that is published throughout the world.

Government documents are not dusty tomes to be forgotten on library shelves. They are the means of exchanging information which is part of the lifeblood of science. Scientific progress and economic development among countries advance by using the work and the information of all people. As the publications of all governments are used to their fullest extent within their

own borders and in the world at large, the world of science is approaching that true internationalism of correlating all knowledge for the good of mankind.

SELECTED PUBLICATIONS OF NATIONAL GOVERNMENTS OF INTEREST IN CHEMICAL RESEARCH

This list is not complete but is rather an introduction to a vast field of potential information. Information given is as complete as could be obtained from the sources consulted. It is the intention of the author to continue this study until all available information has been obtained and to publish these results at a future time.

AFRICA (EAST)
- Reports
  - East African Agricultural Research Station

AFRICA (SOUTH)
- Lists
  - General list of government publications
- Special issues, Department of Mines
  - Mineral resources of the Union of South Africa, 1940

ARGENTINA
- Pamphlets and Bulletins
  - *Publicaciones de la facultad de ciencias matematicas, fisico-quimicas y naturales aplicadas a la industria de la universidad nacional del Litoral, Rosario*
    1. *Serie Tecnico-cientifica*, 1935–. 2–4 issues a year. 7 pesos a copy. Exchange requested. Scholarly research articles by the faculty.
    2. *Serie Universitaria*. 1935–. 3–4 issues a year.
    3. *Serie Conferencias y Textos*. 1937–. 3–6 issues a year.
- Journals (issued by educational institutions)
  - *Publicaciones del instituto de investigaciones microquimicas.* Founded in 1936. Exchange requested. Publication of National University of Litoral, Rosario. Devoted to study of microchemistry, microanalysis, microcrystallography, and related branches.
  - *Revista de la facultad de ciencias quimicas.* Irregular. Founded in 1923. Organ of the chemical and pharmacy faculty of the National University of La Plata. Research articles on theoretical, applied, and industrial aspects of pharmacy and chemistry.
  - *Revista del centro estudiantes de farmacia y bioquimica.* Founded in 1911. Monthly. Organ of the faculty of medical sciences of the University of Buenos Aires. Original publications by faculty and students on pharmacy and chemistry.

AUSTRALIA

Council for Scientific and Industrial Research
- Lists of Publications
  - Committees, Divisions, Publications, etc., as of January, 1945.
- Bulletins
  - 27. Australian clays in the manufacture of white pottery
  - 31. Newsprint-preliminary experiments on mechanical pulp
  - 36. Kimberly horse disease
  - 50. The poisonous action of ingested saponins
  - 167. The detonation of nitroglycerin by impact
- Pamphlets (pamphlet series now terminated)
  - 9. A forest products laboratory for Australia
  - 23. Refrigeration applied to preservation and transport of Australian foodstuffs
  - 32. The chemistry of Australian timber
  - 53. The identification of wood by chemical means
  - 115. Studies on the shrink proofing of wool
- Periodicals
  - *Journal of the Council for Scientific and Industrial Research*
- Trade Circulars
  - 9. Electrical moisture meters for measuring moisture content of timber
  - 28. The chemistry of wood
- Special Issues (Industrial chemical circulars)
  - 1. Some technical aspects of foundry cores
  - 2. Investigation of low tin and tin free solders
  - 3. Melting and casting of magnesium alloys
  - 4. Separation of ergot from rye corn
- Technical communications, Department of Agriculture, Bureau of Sugar Experiment Stations
- Bulletins, Department of Education, Sydney Technological Museum
  - 2. Guide to the examination of commercial eucalyptus oils
  - 4. Guide to the extraction of eucalyptus oils in the field
  - 12. Tung oil from Australian grown trees of *Aleurites fordii*
  - 15. Ambergris and how to recognize it
  - 16. Grass tree resin
  - 17. Uses of commercial eucalyptus oils
  - 21. The rot-proofing of jute Hessian
- Technical Education Series
  - 24. Eucalypts and their essential oils
  - 26. A study of the effect of sway on trees, Forestry Bureau
  - Classification guide and ration scales for motor spirit and diesel oil fuel, 1940, Liquid Fuel Control Board
- Reports, National Health and Medical Research Council
- Annual catalog of Australian publications (this includes the issues of all departments). No issue since 1940 due to war censorship regulations. National Library.

BRAZIL
- Journals issued by educational institutions
  - *Boletim da academia nacional de farmacia*
  - *Boletim do instituto de quimica agricola. Rio de Janeiro*
- Reports
  - Ministry of Foreign Affairs (Annual)

CANADA
- Technical Bulletins
  - Department of Agriculture
  - Department of Interior (Forest Service)
  - Department of Mines
  - Dominion Water Power and Hydrometric Bureau
    - Water resources papers
  - Fisheries Research Board
  - Department of Trade and Commerce, Dominion Bureau of Standards
    - Chemicals and allied products in Canada, 1937–38
    - Registration and licensing of chemical stills, 1939
    - The acids, alkalies, and salts industry, 1943
    - The miscellaneous chemical products industry, 1943
    - The coal tar distillation industry, 1943
    - The adhesives industry
    - The fertilizer manufacturing industry, 1941–43
    - The compressed gases industry, 1942
    - The natural gas industry, 1938
    - The inks industry, 1943
    - Medicinal and pharmaceutical preparations industry, 1943
    - Consumption of chemicals in municipal waterworks in Canada, 1942–43
- Reports
  - Department of Mines (Annual)
  - Dominion Grain Research Laboratories
  - Fisheries Research Board
    - Progress reports of Atlantic coast stations
    - Progress reports of Pacific coast stations

CHILE
- Journals issued by educational institutions
  - *Revista de ingenieria quimica.* Publication of the School of Chemical Engineering, University of Concepçion

CHINA
- Journals
  - *Journal of Industrial Research*
- Reports
  - Science report of Tsing Hwa University
  - *Academia Sineca* of National Academy of Peiping (annual)

ECUADOR
- Journals issued by educational institutions

Revista de la asociacion de la escuela de quimica y farmacia. Founded 1943. Organ of the Association of Students of Chemistry and Pharmacy of the Central University of Quito. Distributed free to scientists and scientific societies devoted to chemistry and pharmacy.

INDIA
- Lists, indexes, and bibliographies
  - Catalog of civil publications compiled and corrected up to December 31, 1940. Government of India Central publications branch, Civil lines, Delhi.
  - Industrial publications published in India from 1921. Bulletin of Indian Industrial Research Number 1.
- Technical Bulletins
  - Industrial Research Bureau
  - Indian Stores Department Standard Specifications
- Journals
  - *Indian Journal of Veterinary Science and Animal Husbandry*

NEW ZEALAND
- Journals
  - *New Zealand Journal of Science and Technology*

PERU
- Journals
  - Journals of educational institutions
    - *Boletin del quimico Peruano.* University Association of Industrial Chemistry

RUSSIA
- Technical Bulletins
  - Institute of Genetics
- Reports
  - Lenin Academy of Agricultural Sciences of U. S. S. R.
  - Leningrad Chemical-Technological Institute

SWEDEN
- Journals
  - *Journal of Royal Swedish Academy of Agriculture*

UNITED KINGDOM
- Indexes, lists, and bibliographies
  - Consolidated list of government publications issued annually
  - Lists of nonparliamentary publications—departmental
    - Aeronautical research committee
    - Ministry of agriculture and fisheries
    - Science museum
    - Ministry of fuel and power
    - Ministry of health
    - Home office (drugs, explosives, pharmacy, and poisons)
    - Medical research council
    - Department of Scientific and Industrial Research
    - Board of Trade
    - War Office
- Technical bulletins
  - Science Museum
    - "Chemistry," by A. Barclay
    - "Atom Tracks," by F. A. B. Ward, 1937
    - "Electric Illumination," by W. T. O'Dea, 1936
    - "Television," ed. by G. R. M. Garratt, 1937
  - War Office
    - Handbooks and manuals
      - Manual of dispensing, 1938
      - Medical manual of chemical warfare
    - School of military engineering pamphlets
- Reports
  - Fuel Research Board (series)
  - Industrial Health Research Board (series)
  - Medical Research Council (series)
  - Scientific and Industrial Research, Chemical Research Board (series)
- Journals
  - Agriculture. *Journal of the Department of Agriculture and Fisheries*
  - *Bulletin of War Medicine*
  - *Journal of Ministry of Agriculture*
  - War Office, Army Medical Department Bulletin

(The United Kingdom also issues a monthly list of publications and an annual report of the colonies)

PUBLICATIONS DEALING WITH TRADE AND MARKET INFORMATION IN THE CHEMICAL INDUSTRY

Due to the fact that the practice of issuing annual reports on exports and imports is universal, these titles have not been repeated unless they possessed some special feature. These annual publications from all countries can be consulted at the Department of Commerce in Washington, D. C.

AFRICA (SOUTH)
- Department of Customs and Excise
  - Annual statement of the trade and shipping of the Union of South Africa and the Territory of Southwest Africa

AUSTRALIA
- Department of Commerce
  - Annual report of commerce and trade in United States, Canada, China, etc.
  - Weekly news bulletin
  - Australian trade commission notes
  - Information bulletin

BRAZIL
- Brazilian Trade Bureau, 551 Fifth Avenue, New York, New York
  - Brazilian Bulletin, semi-monthly, free (annual report listed in other section also contains trade information)

CANADA
- Department of Trade and Commerce, Bureau of Statistics
  - Chemicals and allied products in Canada, 1939–
  - Nonferrous metals and their products
  - Agricultural and vegetable products

INDIA
- Indian Tariff Board
  - Reports
- Handbook of commercial information for India
- Annual statement of the sea-borne trade of British India with the British Empire and foreign countries, 1938

NEW ZEALAND
- Department of Commerce
  - Statistical report on trade and shipping in New Zealand

RUSSIA
- American-Russian Chamber of Commerce, 261 Fifth Avenue, New York, New York
  - Chemical industry in the third five-year plan. Bulletin 690. May, 1939.
  - U. S. imports from U. S. S. R., 1941. Bulletin 760, June 1944
  - U. S. exports to U. S. S. R., 1941. Bulletin 761, June, 1944
  - U. S. imports from U. S. S. R., 1942. Bulletin 776, June, 1945
  - U. S. exports to U. S. S. R., 1942. Bulletin 777, June, 1945
  - U. S. imports from U. S. S. R., 1943–1944. Bulletin 782, October, 1945
  - U. S. exports to U. S. S. R. for military equipment, 1944. Bulletin 784, December, 1945

SWEDEN
- Swedish Chamber of Commerce of the U. S. A., 45 Rockefeller Plaza, New York, New York
  - Annual reports
  - American Swedish Monthly

UNITED KINGDOM
- Department of customs and excise
  - Annual statement of trade of the United Kingdom, suspended during the war
- Board of Trade
  - Final report of the fifth census of production, 1935
  - Part III, The food, drink, and tobacco trades, the chemical and allied trades, 1940.
  - Statistical abstract of the United Kingdom for each of 15 years, 1924–1938
  - Reports of Department of Customs and Excise of the various colonies

Punch Card Techniques and Applications[1]

ROBERT S. CASEY and C. F. BAILEY

W. A. Sheaffer Pen Company, Fort Madison, Iowa

GERALD J. COX

Corn Products Refining Company, Argo, Illinois

YEAR by year there has been an ever-mounting tempo in scientific research. More and more workers have been attracted to this field of endeavor, more and more laboratories have been established, more and more information has been forthcoming. The war, with its heavy and exacting demands, has served as a powerful stimulus. With respect to the future most observers expect a continuance in the trend toward a steadily expanding volume of scientific work.

Such facts concerning the past and beliefs regarding the future are a source of deep satisfaction and inspiration in all respects save one. This one respect, we must, in the words of the old time politician, "view with alarm." We refer, of course, to the increasing difficulty of coping with the torrent of data and information that emanates from the laboratories. The mere existence of this mass of information is of little consequence unless it can be located and utilized efficiently for the benefit of all.

Having stated the problem, we now may logically ask, "What can be done about the situation?" Viewing with alarm is quite useless if it is done despairingly. On the other hand, it reflects a healthy and constructive condition if it stimulates scientists to seek new and improved methods for effective indexing and organization of existing scientific knowledge.

The present authors claim no originality for these ideas which have appeared frequently in print and which are discussed wherever scientists gather. Bush (*1*) has given an especially interesting and able exposition. He has pointed out the urgent need for better correlation of the record, and in prophetic vein he has suggested marvelous things that can eventually be done. In Bush's words, "There are plenty of mechanical aids with which to effect a transformation in scientific records." At the same time, he concedes that full development will not come overnight.

With Bush's "Memex" or a similar mechanical device before us as the ultimate goal, we still have to face reality and keep in mind that we must learn to crawl before we can learn to walk or run. We must make immediate use of such aids as are available now, thus taking the first step toward the final goal. It is the aim of this paper to focus attention on one such device which is most useful and versatile— the punch card (*2*, *3*).

Thus far, these cards have found their principal applications in a wide diversity of business uses, such as sales analysis, labor distribution, production control, and personnel records.

Punch cards were also extensively used for military purposes, more than 10,000,000 being expended for personnel classification of the U. S. forces during World War II. One anecdote illustrates their potentialities. It is related that early in the war the U. S. Army wanted to locate six soldiers who could speak Icelandic. The punch cards were consulted, and within less than 48 hours the required personnel were found at widely scattered points and had their travel orders.

The potentialities of punch cards in scientific pursuits are not less than they are in the business world. Thus far, the cards have not been put to extensive scientific usage, but the pioneering has been done, and we foresee rapid expansion as more scientists become aware of their possibilities.

The use of punch cards does not complicate the keeping of data. On the contrary, it simplifies that problem because it eliminates the necessity for multiple cards if it is desired to sort the file according to more than one category, such as author, subject matter and sub-classifications, date, code or serial number, properties, or other criteria. Other advantages appear as one becomes familiar with the techniques described in the next section.

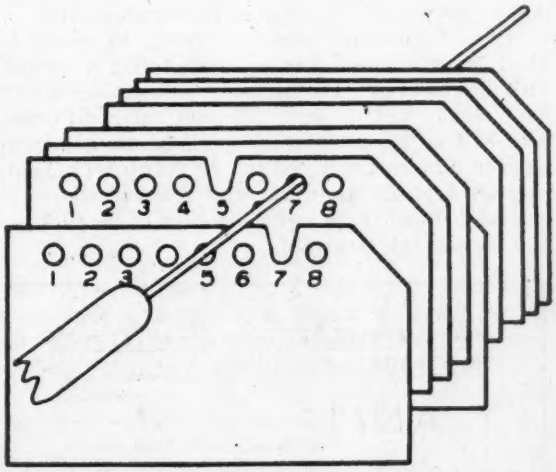


FIGURE 1. DIRECT CODING AND SORTING. ALL CARDS PERTAINING TO DESIRED CLASSIFICATION DROP WITH ONE PASS OF THE SORTING NEEDLE.

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8-12, 1946.

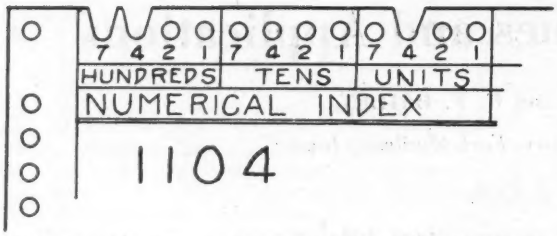


FIGURE 2. NUMERICAL CODING, BY MEANS OF WHICH LARGE NUMBERS MAY BE REACHED WITH LITTLE CARD SPACE; FOR MUTUALLY EXCLUSIVE DATA ONLY.

TECHNIQUES

The principle underlying the use of punch cards is the law of gravity, as shown in Figure 1.

The cards have rows of holes along the edges, and the remainder of the card is unperforated. Quite often the outline to be used for coding purposes can be printed on the cards; however, in cases where the outline is long and space-consuming data are to be entered on the cards, it is better to use a separate outline (see Figure 7) and relatively blank cards.

To each hole is assigned a certain meaning. Those holes whose meanings are applicable to the information listed on that particular card are clipped open, forming a notch. When the sorting needle is passed through one of the holes in a pack of punch cards and lifted, all those cards drop out which bear information keyed to the meaning assigned to that hole. The other cards stay on the needle.

The holes may be clipped open by the use of a hand punch or by a gang punch which can handle a hundred or more cards at a time.

The present authors recently described (*4*) some of the fundamental techniques applicable to punch card use. Those techniques and a few others are illustrated in Figures 1 to 5.

Direct coding and sorting, illustrated in Figure 1, is the simplest because a single pass of the sorting needle in the appropriate hole drops out the required cards.

Figure 2 illustrates numerical coding, by means of which larger numbers may be reached than is possible with direct coding. Furthermore, with numerical coding one may sort the entire file into numerical order. This is done by needling each hole in the numerical index in turn from right to left. As the cards drop out, they are kept always in the same position relative to one another and are placed at the back of the pack before the next hole is needled.

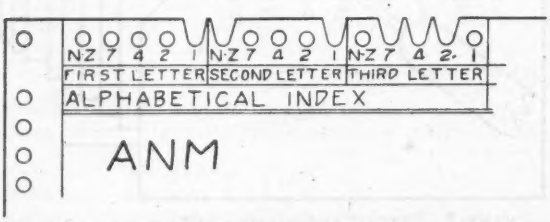


FIGURE 3. ONE TYPE OF INDEX FOR ALPHABETICAL CODING; A SPECIAL APPLICATION OF NUMERICAL CODING

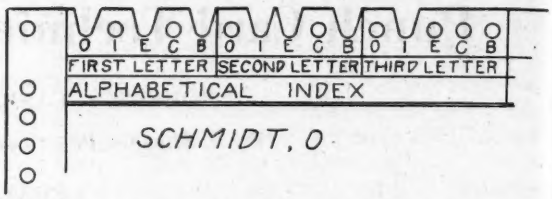


FIGURE 4. ALPHABETICAL CODING WITH NEW TYPE OF MNEMONIC INDEX

Alphabetical coding shown in Figure 3 is merely a special case of numerical coding. The mnemonic code illustrated in Figure 4 and discussed in a later section may also be used for alphabetical coding.

In addition to sorting the whole file into numerical order, it may be desired to select from the file a card or cards coded with a particular number. This can be done by coding in "fields" illustrated in Figure 5 and using a "selector," which is a sorting device having movable, multiple tines. This sorting system utilizes in addition to the usual 7-4-2-1[2] field, two additional holes, one marked "0" (zero) and the other "S.F." (single figure). If zero is to be indicated in a given field, the "0" hole is the only one slotted. If 7 or 4 or 2 or 1 is to be indicated, the appropriate one of those "single figures" is slotted, along with the "S.F." hole.

Figure 6 illustrates a double row of holes and shows how each position may be slotted in any one of three ways—shallow, middle, or deep. This arrangement increases the versatility of the cards since any one of the numbered positions may be given *three* meanings instead of one. It also permits the two rows of holes to be used independently for the serial sorting of *two* sets of fields. For example, if the outer row of holes has already been used (with the shallow punch), it still may be desired to index a new category not anticipated at the time the cards were prepared. This can be done by assigning the new set of meanings to the holes in the second row and punching the appropriate positions with the middle punch. This does not interfere with independent sorting of the outer row. When the holes in the second row are needled, the punched cards drop about one quarter inch and may be swung to one side and separated. If the outer hole in any position is slotted also, the card drops free of the needle when a slotted inner hole in that position is needled.

A direct index should be used for coding data which are not mutually exclusive and more than one of which may occur on any one card. A numerical index can be used for indicating any one (but only one) of a large number of mutually exclusive data. An alphabetical index can be used similarly or can be used to list names or the first few letters of names.

Dates can be coded on a numerical index. Units and tens fields indicate the year with a few other holes for the century.

The latter three types of coding may be used to sort

[2] The substitution of "7" for "8" in the geometric series 1, 2, 4, 8, 16, . . . makes it possible to represent any digit by not more than two punches.

the whole file into order—numerical, alphabetical, or chronological—or to change the file from one order to another. This means, then, that filing in its usual sense is eliminated since the manner of putting data into the file is unimportant. Instead, emphasis is placed solely on the means of getting information out of the file.

Several numerical and alphabetical indexes can be used on one card, with or without a certain number of holes for direct coding, or on the other hand, all the holes may be used for direct coding.

The upper right corner of each card is cut diagonally to indicate whether all the cards in the group are right side up and facing the same way. If a group of cards is in random arrangement, needling the corner hole in the upper right drops out all the cards which are right side up and facing the operator. By shifting the cards and repeating, the whole group may be faced properly with three passes of the sorting needle.

Mistakes may be corrected by the use of "card savers." These are strips of gummed paper punched to conform to the holes in the cards.

Punch cards may be had in sizes ranging from a few inches on a side up to letter size, $8\frac{1}{2}$ inches × 11 inches. The cards and accessory equipment, as well as additional instructions and technical bulletins, may be obtained from the McBee Company ("Keysort"), Athens, Ohio, and the Charles R. Hadley Company ("Rocket"), Los Angeles, California.

APPLICATIONS

Numerous applications follow as logical consequences of the principal properties of punch cards. All specific applications cannot be covered here, even in a general way. Almost their only limitations are the need and ingenuity of the user.

A few examples and suggestions will be given as illustrating the possibilities.

The application of punch cards may be said to be for the tabulation and correlation of data. Bibliography preparation is an example of such correlation applied to published data.

The present authors have reported their use of punch cards for the preparation of bibliographies in di-

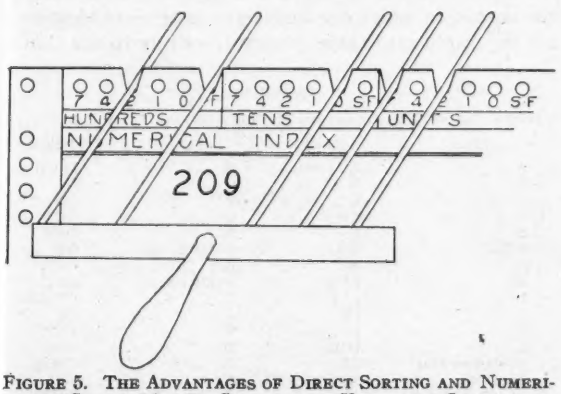


FIGURE 5. THE ADVANTAGES OF DIRECT SORTING AND NUMERICAL CODING MAY BE COMBINED BY USE OF THE SELECTOR

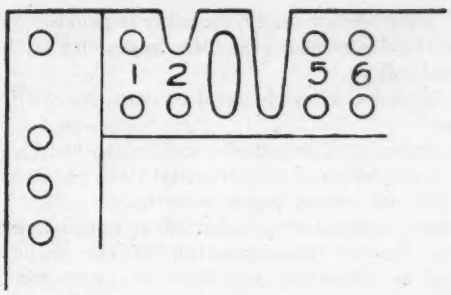


FIGURE 6. THE DOUBLE ROW OF HOLES GREATLY INCREASES THE AMOUNT OF INFORMATION WHICH CAN BE CODED

verse chemical fields (*4*). Subsequent experience has demonstrated that this type of bibliography is admirably suited to manuscript preparation, especially one involving numerous citations. For example, the file of cards may be sorted for subject matter required for the manuscript. These selected cards then may be sorted chronologically. Arrangement of references at the end of the manuscript is facilitated by the ability to sort the cards according to author and serial number.

Others have also reported the use of punch cards for bibliography. The first of which we find a literature record is an English metallurgical worker (*5*). Since that time there have been two more reports in the field of metallurgy (*6, 7*), two in physiology (*8, 9*), and one in pharmacology (*10*).

A second type of correlation using punch cards is that applied to experimental and observational results. Curiously, most have been biological.

Cox and his coworkers (*11*) have used punch cards for the analysis of data obtained from studies on dental caries in rats.

A very interesting application has been made by Wright (*12*), who used punch cards to correlate the data required for identification of organic compounds by means of their infrared spectra. His code (*13*) is a model of simplicity in that only direct coding is used.

Frear (*14*) has applied the method to a statistical study of the relationship between the chemical constitution of about 8000 compounds and their toxicity to fungi and insects. A particularly valuable feature of the cards, according to Frear (*15*), is that they have enabled him to study combinations of chemical groups as well as individual groups.

There have been other applications concerning which we have less direct information. In these cases we have merely seen the cards, and in the absence of the codes or other information we could only deduce the general purpose but not the details. Therefore, we can go no further than to list our own brief, general observations regarding the purposes of these several cards:

1. A study involving observations on mottled and carious conditions of human teeth.
2. Correlation of ocular data.
3. Diagnostic file used by a tuberculosis league located in a large city.
4. File for keeping obstetrical case histories.

5. A correlation study, probably in genetics, carried out in the department of poultry husbandry of an agricultural college.

6. Correlation of chemical constitution with properties.

7. Indexing of insecticides and fungicides.

8. Correlation of experimental data obtained in a chemical and bacteriological investigation.

A third fruitful field of scientific and engineering correlation lies in the application of the punch card method to chemicals, materials of construction, and processes. In the file devoted to chemicals the subject matter could be indexed by composition, function, source, commercial availability, possession of a sample, as well as according to other criteria. On the card would be listed the physical constants and other pertinent scientific and technical information concerning that compound. The file could be sorted for a given class of compounds or for a specific compound. It could also be sorted for all materials having a given set of properties, as for example, antioxidants or solvents for nitrocellulose The senior author has done some work on this subject and contemplates publishing more detailed conclusions elsewhere. Suggestions are solicited for outlining and indexing, as applied to the above subjects, particularly the properties and functions which consumers might use to locate chemicals and materials suitable for specific purposes.

MISCELLANEOUS NEW TECHNIQUES

Since writing our first paper (*4*) we have developed several new procedures for the better preparation and manipulation of punch cards for bibliography.

For multiple authorship papers, if the name of the first author only is punched in the three fields for authorship, then all the papers of that author and his colleagues will be sorted in order. The arrangement which results will be chronological if the dates of the papers are serially sorted prior to the alphabetizing. This procedure necessitates preparation of *See* cards for authors if it is desired to find all the papers of a given writer. We have found, however, that we have been so little interested in authorship as compared with subject

Lactic acid 10

7. Melting point, any.
8. Boiling point, any.
9. Analysis. 1. Qual. 2. Quan.
10. Optical activity. 1. Measurement 2. Resolution
11. Acidic properties. 1. Qual. 2. Quan.
12. Solubilities, any.
13. Distribution coefficients
14. Other physical properties
15. Chemical reactions
16. Derivatives other than salts & esters
17. Preparation. 1. Laboratory 2. Commercial
18. Uses. 1. Laboratory 2. Commercial
19. Polymerization
20. Pyrolysis
21. Acrylate
22. Biochemistry. 1. Production 2. Consumption
23. Density
24. Index of refraction
25. Crystal form
26. Lactyl lactic acid & lactide
27.
28.
29.
30.
31.
32.
33.
34.

Classified Index

Section D: Salts
1. Magnesium
2. Calcium
3. Potassium
4. Sodium
5. Double salts
6. Miscellaneous
7. Zinc
8. More than one

Section C: Esters
1. Methyl
2. Ethyl
3. Propyls
4. Butyls
5. Higher aliphatics
6. Aromatics
7. Miscellaneous
8. More than one

FIGURE 7. TYPICAL OFF-THE-CARD OUTLINE FOR INDEXING A SPECIFIC SUBJECT

matter that we are content to use only a few author cards and to rely on the author index of *Chemical Abstracts* as a *See* source for such compilations. Incidentally we follow *Chemical Abstracts* alphabetizing procedures in all cases. For example, "St. Louis" is punched "S-A-I" and not "S-T-L."

In our paper on punch cards for bibliography (*4*) we showed the use of two codes for indexing authors. The mnemonic O-I-E-C-B code for alphabetical coding was originated by one of the authors (G.J.C.), who has since developed it further. A test with 65 names selected at random showed 6.7 punches required per name for the N-Z 7-4-2-1 code and 5.7 for the O-I-E-C-B code. This saving of one punch per name is solely because of the better assignment of punches to each letter. For example, the *a* is not punched for the latter system. The association of letter with letter, however, is a distinct advantage over the number with letter association of the N-Z 7-4-2-1 code.

In the original code for the O-I-E-C-B system a method was presented for separating *Mac* and *Mc* by treating them as separate letters. An even greater advantage is obtained by treating *Sch* as a separate letter as there are about twice as many names in chemical literature beginning with *Sch* as *Mc* or *Mac*. Furthermore there are far more names beginning with *S* that precede *Sch* than names beginning with *M* before *Mac*. Fortunately, a gap in the code was deliberately left after *I* so that *U* would be a combination of vowel punches. Accordingly, the original code has been revised to the one shown in Table 1 to provide for three ways of punching *S*. For names beginning with *Sch* this revision results in alphabetizing to the fifth letter. It has been further found that it is better to punch O-C to represent *qu* instead of only *q*.

If the second or third letter of a name is *m* or *s*, it is possible to effect a further rough separation of names into three groups. A choice is available between three punching combinations to represent *m*. The separation proposed is according to the initial letter of the author's first name. If this initial letter is *A* to *H*, inclusive, the I-E is punched for *M* in second or third place and O-E for *s*; if *I* to *Q*, inclusive, I-E-B and O-E-B are punched; if *R* to *Z*, then I-E-C and O-E-C are used. On sorting, the names, in which the first three letters are identical, are separated into three groups according to the initial

TABLE 1

REVISED CODING FOR ALPHABETICAL INDEX ON THE O-I-E-C-B SYSTEM

Letter	*Punch*	*Letter*	*Punch*
A	No punch	N	IECB
B	B	O	O
C	C	P	OB
D	CB	Qu	OC
E	E	R	OCB
F	EB	S (before Sch)	OE
G	EC	Sch	OEB
H	ECB	S (after Sch)	OEC
I	I	T	OECB
J	IB	U	OI
K	IC	V	OIB
L	ICB	W	OIC
M (before Mac)	IE	X	OICB
Mac, Mc	IEB	Y	OIE
M (after Mc)	IEC	Z	OIEB

letter of the first name. A convenient mnemonic clue to this separation is A-I-R as the leading letters in each of the three groups.

For the selection of a specific author it is necessary to sort the cards. If the complete sorting to alphabetical arrangement is not desired, the cards may be obtained by needling any one of the first three letters of the author's name. The letter to be sought first is the one with the least probability of occurrence. For example, in searching for "Smythe" the third letter field would be sorted for *y* as many more names begin with *s* than have *y* as the third letter. Thus the number of cards to be examined is quickly diminished.

For off-the-card indexes of the coding for specific subjects coded in the "numerical index," we have found it convenient to record the index on a plain 5-inch by 8-inch card as shown in Figure 7. This card then is placed with the punch cards in the file for the specific subjects. For example, the index card for "Lactic acid, numerical index, 10" is placed anywhere in the file of cards dealing with lactic acid, its salts, esters, and related substances. It can be instantly located because of its uncut corner and its lack of marginal perforations. Another example is the previously published (*4*) index for coding writing ink references.

Figure 7, incidentally, shows a working index. The holes 27 to 34, inclusive, remain unassigned and are thus available for later concepts of what should be recorded by punching. The card serves as a reminder to different readers on a subject as to what items are to be abstracted, and hence is an effective stimulus to fuller abstracting of essential features. Holes 1 to 4 of our card have been assigned the following meanings:

Hole	*Shallow punch*	*Deep punch*
1	Original seen, title and reference correct and complete	Available in our laboratory
2	Foreign patent	U. S. patent
3	A copied abstract	An original abstract with or without a copied abstract
4	An idea is recorded, suggested by reading the article	

Holes 5 and 6 in our practice remain unassigned. They are, however, reserved for a use that will apply to all cards.

The authors have used "card savers" as hinges to join two cards when an abstract or other data are too long to be typed on both sides of a single card. The joined cards can be punched and handled as a single card.

The use of rubber bands around groups of cards should be avoided because of the tendency of rubber, particularly under tension, to age and become soft and tacky. This leaves spots which cause cards to stick together. The same thing must be considered when pasting anything to the face of the card. Permanently tacky adhesives should not be used.

We have used red pencil lines on the face of cards to link specific data with the pertinent marginal holes. This device speeds the location of data when a series of cards is being scanned after sorting.

The prerequisite to coding and sorting of punch cards is the analysis, outlining, and sub-classification of the subject matter. Like the chain which is no stronger than its weakest link, the punch card system is no better than the thought given to analysis of the indexing problem at hand. The cards do not think—that remains the province of the user; however, the use of punch cards will at least partially relieve the user of repetitive and noncreative mental effort. As Bush (*1*) so aptly says:

> . . . every time one combines and records facts in accordance with established logical processes, the creative aspect of thinking is concerned only with the selection of the data and the process to be employed, and the manipulation thereafter is repetitive in nature and hence a fit matter to be relegated to the machines.

LITERATURE CITED

(1) BUSH, V., *Atlantic Monthly*, **176**, 101 (1945).
(2) PERKINS, A., U. S. Patents 1,739,087 (1929), 1,544,172 (1925).
(3) NEVIN, D. A., U. S. Patent 2,213,607 (1940).
(4) COX, G. J., C. F. BAILEY, AND R. S. CASEY, *Chem. Eng. News*, **23**, 1623 (1945).
(5) *Metal Ind., London*, **54**, 617 (1939).
(6) WEST, E. G., *Trans. Inst. Welding*, **4**, 187 (1941).
(7) PRICE, G. H. S., *Metal Ind., London*, **64**, 354 (1944).
(8) J., E. M., *Quart. J. Studies Alc.*, **2**, 216 (1941).
(9) BARKER, S. B., private communication.
(10) FEATHERSTONE, R. M., private communication.
(11) COX, G. J., M. L. DODDS, S. F. DIXON, AND M. C. MATUSCHAK, *J. Dental Research*, **18**, 469 (1939).
(12) WRIGHT, N., "Infrared spectrometry," presented before Symposium on "Spectrochemical Methods of Analysis," American Chemical Society, New York, Sept. 12, 1944.
(13) WRIGHT, N., private communication.
(14) FREAR, D. E. H., *Chem. Eng. News*, **23**, 2077 (1945).
(15) FREAR, D. E. H., private communication.

A Punched Card Method for the Bibliography, Abstracting, and Indexing of Chemical Literature[1]

CLOYD DAKE GULL

Library of Congress, Washington, D. C.

THIS paper is intended to outline the possible application of International Business Machines Corporation equipment (punched cards and punching, sorting, filing, and printing machines) to the problem of chemical bibliography and abstracting, particularly in relation to *Chemical Abstracts*. It includes samples of abstracts and indexes, and a comparison of *Chemical Abstracts* with results possible by using ordinary catalog cards and by using punched cards.

All types of bibliographic references for chemical subjects—that is, those which can be expressed in the Roman alphabet and Arabic numerals—can be placed upon International Business Machines punched cards by following a uniform punching guide. Several punched cards form one bibliographic reference unit, and a quantity of these bibliographic units can be sorted and interfiled by machine to permit a maximum flexibility of arrangement.

Since new references can be interfiled whenever desired, punched cards afford the ability to cumulate[2] references at will, so that listings can be produced which are both complete and up-to-date at the time of printing.

In addition to the decided advantages of (1) flexibility of arrangement and (2) ability to cumulate references at any time, the punched cards can be run through a printing machine at the rate of 80 lines a minute. Printed reference lists, up-to-date and in any desired order, are the result in these forms:

These are in large type, direct from the machine	Original, and as many as 9 carbon copies
	Spirit duplication for up to 200 copies (hectograph)
	Flexible mat lithography for up to 3000 copies (duplimat)
Photographically reduced in size	Photolithography for large-scale printed work

Individual requests, then, can be supplied by small-scale printing methods, and wide distribution of uniform information can be made as it is being done now by printing in serial form. It is suggested that the fee basis or service charge method might prove satisfactory in defraying the costs of individual requests, to supplement the present subscription charges for the periodical volumes. Now, if all references on chemical subjects can be placed upon punched cards (and the major obstacle is doubtless that of financial support to accomplish the work), a union bibliography becomes available on punched cards. The union bibliography is capable of being sorted, cumulated, and used for printing, just as are smaller quantities of cards.

The significance of a union bibliography is tremendous, for it offers the possibility of making this statement: "The following references constitute the largest and most complete up-to-date list available on this subject." It offers the ability to eliminate the work of consulting card catalogs, bibliographies, and sets of printed references, and to replace that work with the use of a single list on a subject.

The time consumed by all users of *Chemical Abstracts* in consulting the various indexes and in referring from one volume and page to another is worth a great deal of money to them or to their employers. Any method which offers the possibility of reducing this wasteful use of time is well worth consideration. The adoption of a satisfactory method would justify an increase in the original cost of *Chemical Abstracts* because it would decrease the expense of using *Chemical Abstracts* forever afterwards. Punched cards offer one method of accomplishing this saving.

Let us make a direct and graphic comparison between bibliographies (1) in book form, (2) on catalog cards, and (3) on punched cards, which supply copy for printed books eventually.

BOOK FORM AND SPECIFICALLY WITH REFERENCE TO *CHEMICAL ABSTRACTS*

It is a delicate position for an outsider who has neither seen nor studied the operations of this service to speak before chemists about it, and especially to bring up that it may have disadvantages as well as advantages. Let me say that I am deeply aware of its great value and indispensable nature and that my observations are based on the assumption that you desire a free expression of views so that you may have the best possible abstracting service.

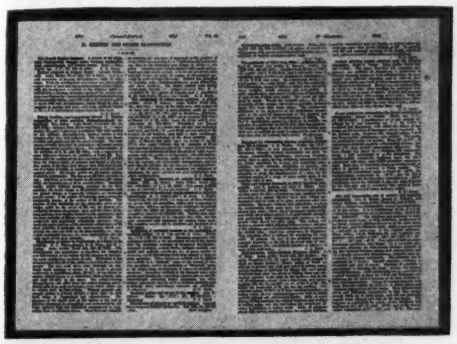
Several thousand columns of references and abstracts appear in 22 issues of *Chemical Abstracts* each year, with the references classified into 31 broad subject groups in each issue (see Figure 1). Altogether they form three bound parts of one volume a year, with each of the 31

[1] Presented before the Division of Chemical Education at the 109th meeting of the American Chemical Society in Atlantic City, April 8–12, 1946.

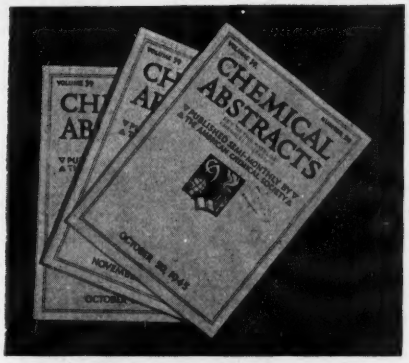
[2] To distinguish between terms, I have used *accumulate* to refer to the chronological and so unplanned growth of an abstracting service, and *cumulate* to refer to the periodic regrouping of like references to bring the abstracting up-to-date. For instance, the annual indexes of *Chemical Abstracts* accumulate as the years pass by; the decennial indexes are cumulative for a ten-year period.

broad subjects scattered throughout the 22 issues. This separation continues year after year, until a comprehensive picture of the literature on a subject is difficult to obtain. Four indexes—author, subject, formula, and patent—are needed to locate references in each annual volume, supplemented by author and subject decennial indexes for each ten year accumulation. To follow a subject through from 1907 requires the use of three decennial indexes and nine annual indexes—12 places to look—and the references may be found scattered in over 800 places in the set of bound volumes. This disadvantage grows each year, and it stems from the fact that the book method offers no flexibility of arrangement and no ability to cumulate references after the printing is done, except by resetting the entire text or holding the type or plates these 40 years past, both exceedingly expensive propositions.

The method means further that from the appear-

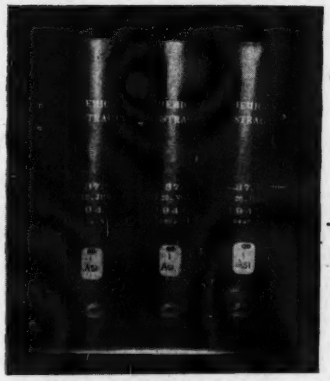


Several thousand columns, in 22 issues per year, each issue with references classified into 31 broad subject groups.



Form 3 bound volumes, with each broad subject scattered in 22 sections.

Four indexes, Author, Subject, Formula and Patent, are used in locating the references, supplemented by Author and Subject Decennial Indexes for each ten year accumulation.



ADVANTAGES

1. Flexible Typography
2. Low printing cost
3. Wide distribution

DISADVANTAGES

1. No flexibility of arrangement
2. No ability to cumulate
3. Necessity of consulting so many sections on a broad subject
4. Necessity of consulting so many indexes
   - A. Author index in each issue, to a blind number
   - B. Author plus Title in yearly volumes and Decennial Index
   - C. Subject in yearly volumes and Decennial Index
   - D. Formula in yearly volume but not in Decennial Index
   - E. Patent in yearly volume but not in Decennial Index

And these indexes require numbers for identification.

FIGURE 1. ABSTRACTS IN BOOK FORM

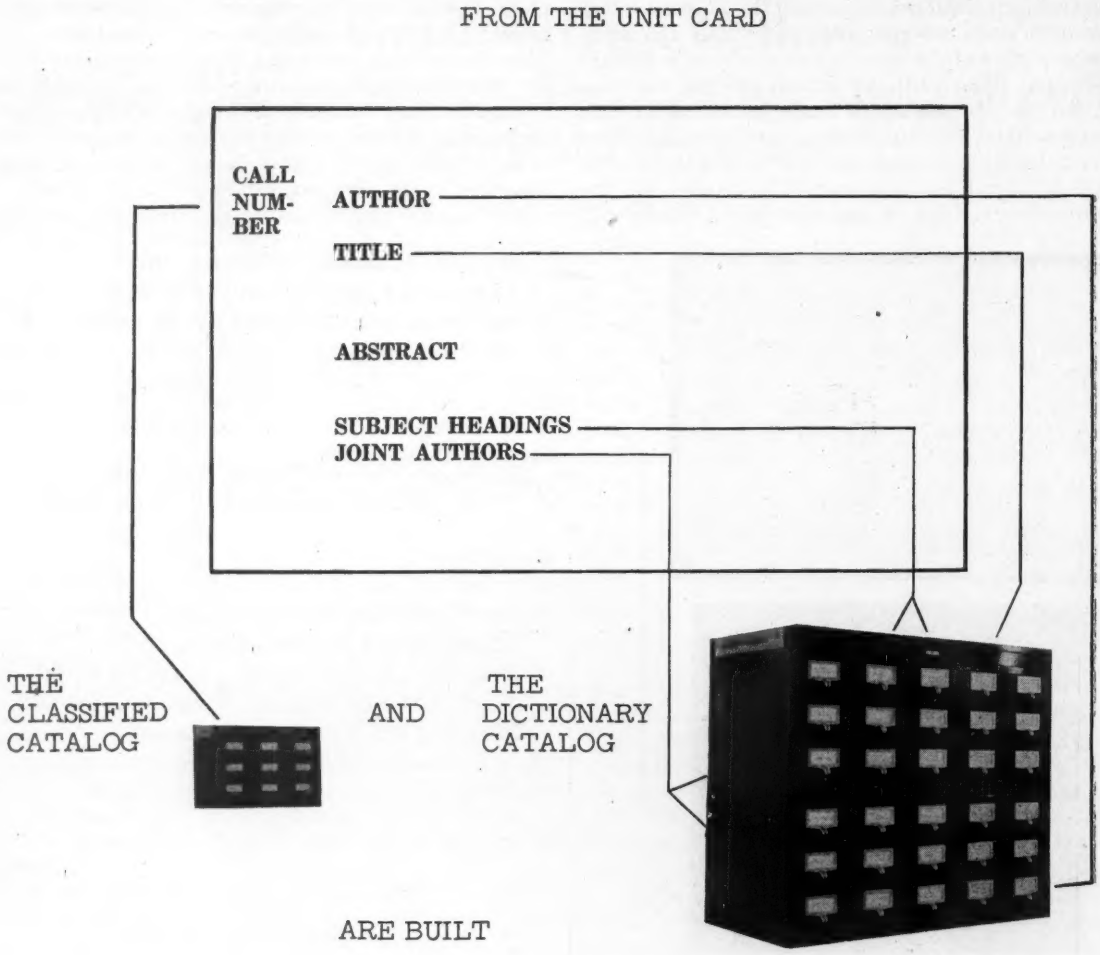
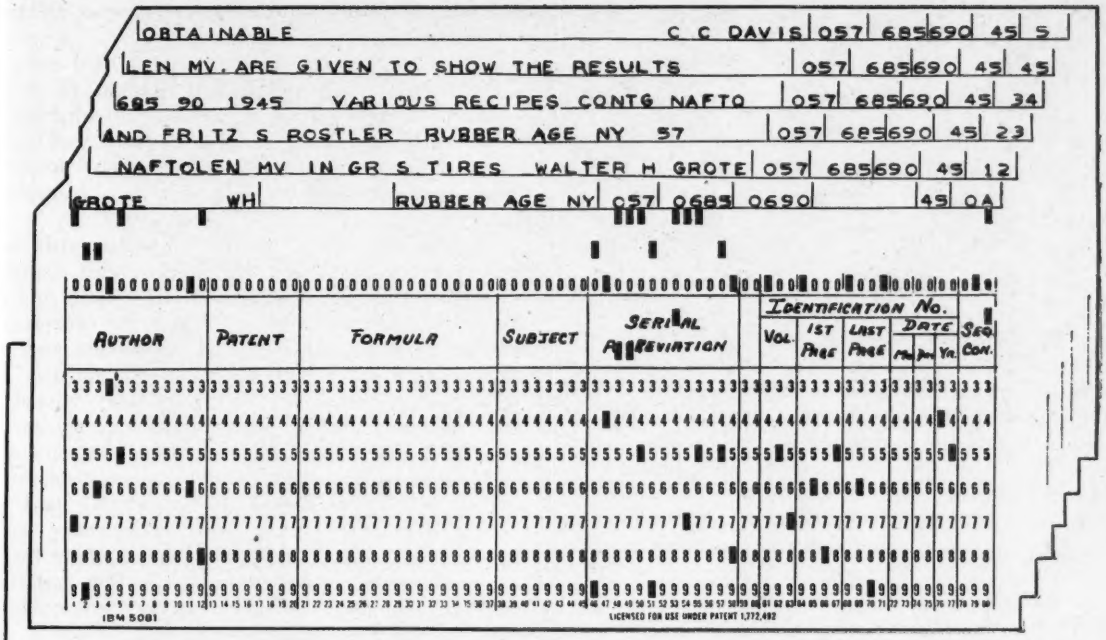


FIGURE 2. ABSTRACTS IN CARD FORM

ance of one subject index to the appearance of the next, a year later, a search for a specific subject must be made through all the bimonthly issues under a broad subject, or that a search for an author's article is made from bimonthly author indexes to a reference number, which is virtually "Blind Man's Buff" for a productive author. All of the indexes require reference numbers to locate the abstracts, and these numbers require a prodigious memory or constant notation in order to use them.

These are serious disadvantages when compared with the printing advantages of a wide choice of type faces and a relatively low cost. Production cost is low, but usage cost is high.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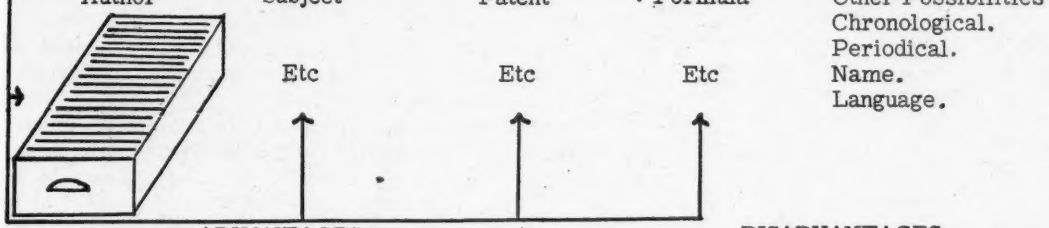
AND FRITZ S ROSTLER RUBBER AGE NY 57 057 685 690 45 23
NAFTOLEN MV IN GR S TIRES WALTER H GROTE 057 685 690 45 12
GROTE WH RUBBER AGE NY 057 0685 0690 45 0A
AUTHOR
PATENT
FORMULA
SUBJECT
SERIAL ABBREVIATION
IDENTIFICATION No.
VOL.
1ST PAGE
LAST PAGE
DATE
SEQ. CON.
IBM 5081
LICENSED FOR USE UNDER PATENT 1,772,402

Several IBM punched cards form one reference unit. Duplicate units can be punched from the original cards. Several sets of units can be established:



ADVANTAGES

1. Flexibility of arrangement
2. Ability to cumulate at will
3. Photograph and print all of one set for wide distribution
4. Print segments to meet individual requests
5. No indexes necessary; each set is its own index
6. Consult only the section desired
7. Machine sorting and filing
8. Reproduction of cards by machine
9. Low printing costs
10. Offers union catalog on chemistry

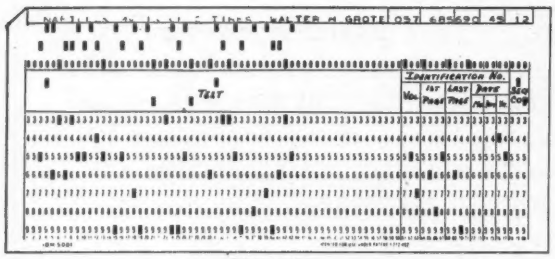
DISADVANTAGES

1. Limited typography
2. Increased paper consumption
3. Storage space for cards at editorial office

FIGURE 3. ABSTRACTS FROM PUNCHED CARDS

CARD CATALOG FORM

The unit card is the foundation of the card catalog (see Figure 2). No matter where the card is filed, the basic information is always the same. The variation occurs in the filing entry. In a library, cards for author, title, subject, and joint authors are filed in their proper places in the dictionary catalog, and cards expressing classification are filed by call number in the classified catalog. For chemists a formula and a patent catalog could be set up by adding the proper filing entries.



TEXT CARD

FIGURE 4. TEXT CARD

The card catalog is flexible, for it can be expanded or cumulated at any time; in fact, it is cumulated always if the filing is kept up-to-date. Its flexibility is limited, for once a card is prepared, its filing location is fixed. A card catalog is useful only where it is maintained, unless the cards are photographed in their proper order and a photolithographed catalog printed, which has been done on a large scale already.[3] Cards must be produced in quantity, the filing entries added, and the cards filed by hand, but no indexes are required with a dictionary catalog because like references are brought together, a great advantage over book catalogs.

PUNCHED CARD FORM

It is now clear that the unit card principle offers the advantages of flexible arrangement, the juxtaposition of like entries, ability to cumulate at any time, and elimination of the need for indexes. When the principle is combined with machinery through the use of punched cards, it provides a bibliographic reference method hitherto unavailable for satisfying individual requests and for meeting large printing needs. After the reference is punched, duplication is done by machine. Sorting, filing, and printing are done by machine (see Figure 3). Individual issues of *Chemical Abstracts* can be photolithographed from punched card printed lists for regular distribution, and after a suitable interval, three to six months, for example, a cumulated issue can replace the earlier issues, which are discarded. A yearly volume can replace the cumulated issues, and eventually a three, five, or ten year set can replace the annual volumes. As these cumulated sets become larger, they mean that only one section need be consulted on a topic in the basic set, plus a very few cumulations bringing the references up-to-date; and no indexes are needed whatever, for each set is its own index since the basic information is the same wherever it is found. It is not necessary to place the references already printed in *Chemical Abstracts* on punched cards; it is sufficient to start now, and in ten years the cumulated set for the next ten years is the basic set because it will then contain the most recent information.

You will ask, "How is this accomplished with punched cards?" Well, several punched cards form one bibliographic reference unit. These cards all contain the same unique number of identification purposes, and they sort, interfile, and print as a unit.

The first card is the sorting card, or card Zero, so named from the zero punched in Column 79 of the Sequence Control Field. It has been divided tentatively as shown in the top card of Figure 3, and it permits sorting upon author, subject, patent, formula, serial or periodical name abbreviation, volume, and date.

The remaining cards, the text or trailer cards, to a limit of 99 for this design, are punched with whatever it is desired to print—that is, the full reference and the abstract, as shown in Figure 4. Sequence control permits arranging the cards in order by machine and prevents the printing of a set of cards out of sequence.

Since a given reference may have been written by more than one author, may contain information on more than one subject, formula, or patent, and may have appeared in more than one periodical, it is necessary to reproduce the unit of several cards to provide duplicate sets of cards for as many variations as are found. This is done by machine for all text cards; the variations in the sorting cards are punched manually and the remaining portion of the sorting cards by machine.

Several sets of cards are now prepared, all referring to one article, and they might be distributed in this way: junior and senior authors to the author file, two subjects to the subject file, one patent to the patent file, and two formulas to the formula file, or seven sets in all.

As the references in each file are accumulated, they are sorted into order and printed, with cumulation, at any desired interval.

These are the principles to be followed in employing punched cards for a union bibliography of chemical references. The technical details are subject to wide variation, such as what identification number to use, the number of spaces for author sorting, and the form of the subject heading code; but they must be studied, and from the studies uniform rules must be adopted.

The possibility of developing the use of the punched cards to the level of a union bibliography of chemical references has been outlined, but any serious consideration of abstracts to supplement the individual references has been omitted. The lack of abstracts in chemical research would be a great loss, and it is evident that they must be supplied. The question is the form in which the abstracts will be satisfactory to the chemical profession.

Chemical Abstracts now uses on its printed page upper and lower case Roman letters in light and bold face fonts of type, an italic font, subscript and superscript numbers, and various chemical diagrams. The International Business Machines printing machine in its present development does not permit this much variety in printing from punched cards. Only the 26 letters of the alphabet (in capitals), the 10 numerals, and three punctuation characters can be punched into cards and used for printing today.

[3] "A Catalog of Books Represented by Library of Congress Printed Cards Issued to July 31, 1942" (an author catalog only).

ROSIN AND TERPENE CHEMICALS IN GR-S TIRE-TREAD COMPOUNDS. LYLE O. AMBERG AND JOHN H. ELLIOTT. INDIA RUBBER WORLD 112 309-12 1945 --TABULATED AND GRAPHICAL DATA SHOW THE EFFECTS OF NUMEROUS COM. PRODUCTS ON THE PROCESSING OF A CONTROL GR-S-C BLACK MIXT. BEFORE VULCANIZATION AND ON SOME OF ITS PHYS. PROPERTIES AFTER VULCANIZATION. THE EXPTS. INDICATE THAT ROSIN DERIVS. IN WHICH THE PREDOMINANT RESIN ACIDS HAVE NOT BEEN DRASTICALLY ALTERED GIVE MIXTS. WHICH CAN BE PROCESSED SATISFACTORILY AND WHICH, AFTER VULCANIZATION, HAVE GOOD TENSILE STRENGTHS AND PARTICULARLY HIGH ELONGATIONS AND RESISTANCE TO OUTGROWTH WHEN FLEXED HOT AFTER AGEING. THE VARIOUS VULCANIZATES SHOWED WIDELY DIFFERING STIFFNESS VALUES AND MOST OF THE SOFTENING AGENTS RETARDED THE RATE OF VULCANIZATION OF THE CONTROL MIXT. WHICH HAS ACCELERATED BY SANTOCURE. THIS RETARDING EFFECT IS REDUCED BY ESTERIFYING THE RESIN ACIDS IN GENERAL THE BEST OF THE PRODUCTS IMPARTED VALUABLE PROPERTIES TO THE GR-S TIRE-TREAD TYPE OF MIXT. LIQUID TERPENES OFFER CONSIDERABLE PROMISE AS ADJUNCTS TO SOME OF THE SOLID RESINS.

C. C. DAVIS

POLYMERIZATION OF ORGANIC COMPOUNDS CONTAINING A VINYL GROUP. BENJAMIN S. GARVEY JR TO B. F. GOODRICH CO. U. S. 2,376,963 MAY 29 1945. AROMATIC DIAZO COMPDS. ARE USED AS INITIATORS FOR THE POLYMERIZATION AND COPOLYMERIZATION OF BUTADIENE AND OTHER UNSATD. ORG. COMPDS. WHICH UNDERGO ADDN. POLYMERIZATION TO FORM LINEAR POLYMERS OF HIGH MOL. WT.

P. E. TOBIAS

NAFTOLEN-MV IN GR-S TIRES- WALTER H. BROTE AND FRITZ S. ROSTLER RUBBER AGE NY 57 685-90 1945 --VARIOUS RECIPES CONTG. NAFTOLEN-MV ARE GIVEN TO SHOW THE RESULTS OBTAINABLE.

C. C. DAVIS

PROCEDURE FOR DETERMINING PHYSICAL PROPERTIES OF FILMS FROM GR-S LATEXES. C. R. PEAKER RUBBER AGE NY 57 423-4 1945 -- A NEW PROCEDURE IS DESCRIBED AND ILLUSTRATED WHEREIN DETAILED INSTRUCTIONS ARE GIVEN FOR MIXING, COMPOUNDING INGREDIENTS, INCREASING VISCOSITY, PREPG. FILMS ON GLASS, DRYING, STRIPPING, VULCANIZING IN HOT AIR, PREPG. SPECIMENS FOR TESTING AND MEASURING STRESS RUPTURE, AND PERMANENT SET. IN COMPARING DIFFERENT LATEXES, IT IS OFTEN ADVISABLE TO JUDGE THE CHARACTERISTICS OF A LATEX BY THE AVERAGED RESULTS OF A RANGE OF CURES RATHER THAN OF THE OPTIMUM STATE OF CURE. C. C. DAVIS

FIGURE 5

Nevertheless, abstracts can be added to any chemical reference so long as they stay within these limitations (see Figure 5). It is believed that these limitations are outweighed by the flexibility of arrangement, the ability to cumulate, and the ability to produce a union bibliography, which are made possible by the use of punched cards. If the chemical profession does not agree with this belief, it is possible that an experimental punched card printing machine now on its way to the Library of Congress may provide a satisfactory typography. If not this machine, certainly one will be developed before long which will answer the need.

*Atlas Powder Co., 4628[3].
*Attapulgus Clay Co., 4747[8].
*Atwood, F. C., 4621[5].
*Austenal Laboratories, Inc., 4736[6].
*Austin, C. R. 4736[2].
Avens, A. W., 4713[6].
Avery, R. A., 4537[3].

Babcock, A. B., 4742[6].
*Bacher, F. A., 4730[7].
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Baird, K. A., 4699[2].
*Baker, B. R., 4727[5].
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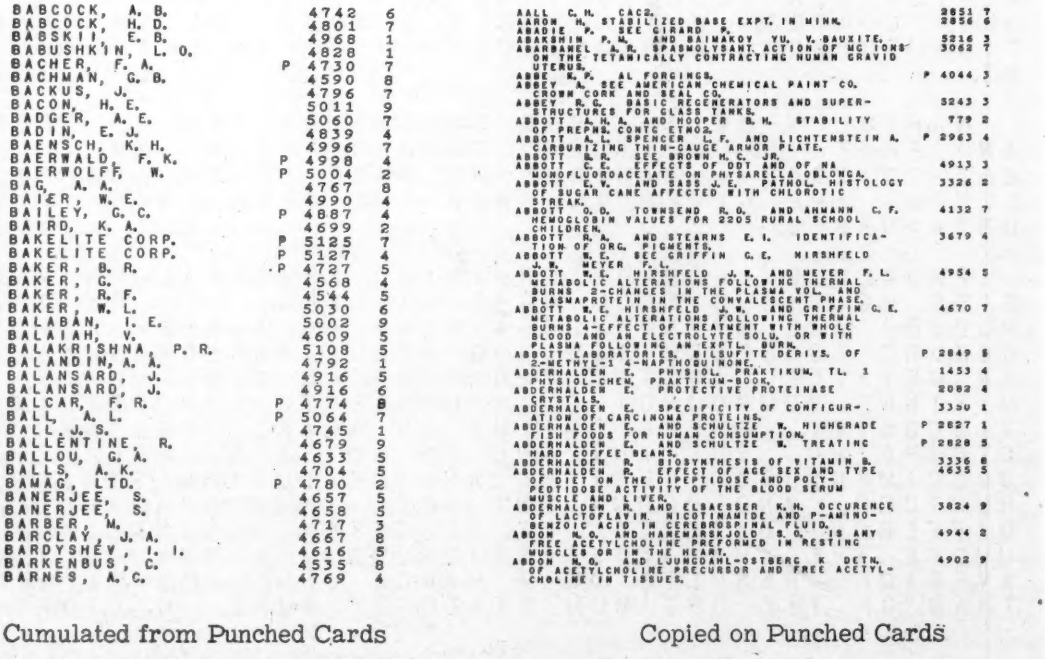
Baker, R. F., 4544[5].
Balaiah, V., 4609[5].
*Balcar, F. R., 4774[8].
Ball, J. S., 4745[1].
Ballentine, R., 4679[9].
Ballou, G. A., 4633[5].
*Balls, A. K., 4704[5].
Banerjee, S., 4657[5], 4658[5].
Barber, M., 4717[3].
Barclay, J. A., 4667[8].
Bardyshev, I. I., 4616[5].
Barkenbus, C., 4535[8].
Barnes, A. C., 4769[4].

Babcock, H. D., 4801[7].
Babskii, E. B., 4968[1].
Babushkin, L. O., 4828[1].
Backus, J., 4796[7].
Bacon, H. E., 5011[9].
Badger, A. E., 5060[7].
Badin, E. J., 4839[4].
Baensch, K. H., 4996[7].
*Baerwald, F. K., 4998[4].
*Baerwolff, W., 5004[2].
Baier, W. E., 4990[4].
*Bailey, G. C., 4887[4].
*Bakelite Corp., 5125[7], 5127[4].
Baker, W. L., 5030[6].
Balaban, I. E., 5002[9].
Balakrishna, P. R., 5108[5].
Balandin, A. A., 4792[1].
Balansard, J., 4916[5], 4916[6].
*Ball, A. L., 5064[7].
*Bamag, Ltd., 4780[2].
Banerjea, A. K., 4801[6].
Barbee, J. F., 5065[1].
Bardgett, H., 5068[7].
Barker, H. A., 4848[9].
Barnes, A. W., 4807[9].

Aall, C. H. CaC_2, 2851[7].
Aaron, H. Stabilized-base expt. in Minn., 2856[6].
Abadie, P. See Girard, P.
Abakshin, P. M., and Balmakov, Yu. V. Bauxite, 5216[1].
Abarbanel, A. R. Spasmolysant action of Mg ions on the tetanically contracting human gravid uterus, 3062[7].
Abbe, K. P. Al forgings, P 4044[3].
Abbey, A. See American Chemical Paint Co.; Crown Cork & Seal Co.
Abbey, R. G. Basic regenerators and superstructures for glass tanks, 5423[8].
Abbott, A. H. A., and Hooper, B. H. Stability of prepns. contg. $EtNO_3$, 779[9].
Abbott, A. L., Spencer, L. F., and Lichtenstein, A. Carburizing thin-gage armor plate, P 2963[4].
Abbott, B. R. See Brown, H. C., Jr.
Abbott, C. E. Effects of DDT and of Na monofluoroacetate on *Physarella oblonga*, 4913[3].
Abbott, E. V., and Sass, J. E. Pathol. histology of sugar cane affected with chlorotic streak, 3326[2].
Abbott, O. D., Townsend, R. O. and Ahmann, C. F. Hemoglobin values for 2,205 rural school children, 4132[7].
Abbott, R. A., and Stearns, E. I. Identification of org. pigments, 3679[4].
Abbott, W. E. See Griffin, G. E.; Hirshfeld, J. W.; Meyer, F. L.

Oct. 20, 1945 Nov. 10, 1945 1945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BACHMAN, G. B. 4590 8
BACKUS, J. 4796 7
BACON, H. E. 5011 9
BADGER, A. E. 5060 7
BADIN, E. J. 4839 4
BAENSCH, K. H. 4996 7
BAERWALD, F. K. P 4998 4
BAERWOLFF, W. P 5004 2
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BAIER, W. E. 4990 4
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BAKELITE CORP. P 5127 4
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BAKER, G. 4568 4
BAKER, R. F. 4544 5
BAKER, W. L. 5030 6
BALABAN, I. E. 5002 9
BALAIAH, V. 4609 5
BALAKRISHNA, P. R. 5108 5
BALANDIN, A. A. 4792 1
BALANSARD, J. 4916 5
BALANSARD, J. 4916 6
BALCAR, F. R. P 4774 8
BALL, A. L. P 5064 7
BALL, J. S. 4745 1
BALLENTINE, R. 4679 9
BALLOU, G. A. 4633 5
BALLS, A. K. 4704 5
BAMAG, LTD. P 4780 2
BANERJEE, S. 4657 5
BANERJEE, S. 4658 5
BARBER, M. 4717 3
BARCLAY, J. A. 4667 8
BARDYSHEV, I. I. 4616 5
BARKENBUS, C. 4535 8
BARNES, A. C. 4769 4
AALL, C. H. CAC2. 2851 7
AARON, H. STABILIZED BASE EXPT. IN MINN. 2856 6
ABADIE, P. SEE GIRARD, P.
ABAKSHIN, P. M. AND BALMAKOV, YU. V. BAUXITE. 5216 3
ABARBANEL, A. R. SPASMOLYSANT ACTION OF MG IONS ON THE TETANICALLY CONTRACTING HUMAN GRAVID UTERUS. 3062 7
ABBE, K. P. AL FORGINGS. P 4044 3
ABBEY, A. SEE AMERICAN CHEMICAL PAINT CO.
CROWN CORK AND SEAL CO.
ABBEY, R. G. BASIC REGENERATORS AND SUPERSTRUCTURES FOR GLASS TANKS. 5243 3
ABBOTT, A. H. A. AND HOOPER B. H. STABILITY OF PREPNS. CONTG ETNO2. 779 2
ABBOTT, A. L., SPENCER L. F. AND LICHTENSTEIN A. CARBURIZING THIN-GAUGE ARMOR PLATE. P 2963 4
ABBOTT, B. R. SEE BROWN H. C. JR.
ABBOTT, C. E. EFFECTS OF DDT AND OF NA MONOFLUOROACETATE ON PHYSARELLA OBLONGA. 4913 3
ABBOTT, E. V. AND SASS J. E. PATHOL. HISTOLOGY OF SUGAR CANE AFFECTED WITH CHLOROTIC STREAK. 3326 2
ABBOTT, O. D. TOWNSEND R. O. AND AHMANN C. F. HEMOGLOBIN VALUES FOR 2205 RURAL SCHOOL CHILDREN. 4132 7
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Cumulated from Punched Cards Copied on Punched Cards

FIGURE 6. THE SAME PRINCIPLE IS FOLLOWED FOR SUBJECT, PATENT, AND FORMULA INDEXES

The punched card method is feasible for recording chemical references alone with the machines now available. Its limited typography indicates a delay until better machines are designed before the punched card method is applied to the larger problem of references plus abstracts.

Meanwhile, punched cards and present equipment offer new possibilities right now for solving the problem of the indexes to *Chemical Abstracts*. These indexes are large undertakings in themselves, and the work of arranging, cumulating, and printing them can be simplified by placing the index information on punched cards at the time the abstracts are made. With the current indexes on punched cards, two or three cumulations of the author index during the year will greatly reduce the work required in using current issues from that approach. Cumulations of the subject, patent, and formula indexes immediately become possible for intervals more frequent than once a year.

A cumulated index (author, subject, patent, and formula sections) becomes possible for all references since Volume 1 appeared in 1907. This possibility is well worth consideration, so that the next decennial index, presumably to cover 1937–1946, covers not only ten years, but changes its character and becomes a cumulative index of the first 40 years (see Figure 6).

Better still, the index can be designed so that it refers directly to the article as well as to its abstract in the bound volumes. Then include all references before 1907 and all omitted since then, and the index becomes a union index to all chemical literature.

Of the questions that may possibly be in your minds now, probably the first one is that of cost, and I can give you nearly nothing for an answer. The samples you have seen were done as experiments, and time was not considered. A girl at $2000 a year ought to punch at least 1000 cards a day, or to phrase it differently, the cost of punching ought to be lower than the cost of setting type. *Chemical Abstracts* would require many machines, and they are rented at various monthly fees. Assuming that all current operating costs are equal for a typeset job or for a punched card job, the savings should accumulate as time goes on, for the punched cards are the basic files and new printing done from them provides for easier use of the service and reduces the original cost with every printing made from them.

The American Chemical Society has appointed a committee to study the far-reaching possibilities of punched cards when applied to the abstracting problem. If there is any way in which I can be of assistance in trying to answer further questions, it will be a pleasure to help.

A CHEMIST'S PRAYER

The following was sent us recently, written by Therese Southgate, a student in the College of Saint Francis, Joliet, Illinois.

I am like a chemical compound in Your Laboratory of Life, O Lord, a compound from which the element Perfection has not yet been isolated, a compound in which the properties of the element Perfection are disguised by combination with earthly vanities. Take me then, O Lord, analyze me according to my good and evil constituents and isolate the pure element Perfection, as a chemist analyzes and separates from a substance all foreign matter. Analyze me that I may learn to know myself and that I may emerge a pure element, worthy to be included in the group of elements already freed from the bonds of their earthly life.

First, grind me in the mortar of childish whims, that I may emerge a composite sample of Your Likeness. Weigh me on the balance of Your generosity and decide how great a sample I shall be in Your Laboratory of Life. Then, ignite me in the furnace of Your love, that the carbon dioxide of earthly vanities be driven off. Cool me with the balm of Your mercy. Dissolve me in Your grace and filter me through the fine mesh of earthly trials so that imperfections may be banished. Precipitate my evil tendencies with the strong precipitant of Your justice and isolate them from Your compound. Precipitate the gelatinous silicate of earthly attachments which draw me from You. Imprison me in Your love with the mordant of sacrifice. Digest me in the length of my life, that my good deeds will grow and that self-satisfaction shall not be occluded with them. Blast out any impurities that may be introduced and finally, seal me forever, a pure substance in the container of your Eternal Happiness.

Nuclear Energetics

RUSSELL R. WILLIAMS, JR.

Monsanto Chemical Company, Oak Ridge, Tennessee

This is the third of a series of articles written by Oak Ridge scientists, on the chemical significance of modern nuclear science and technology.

IN A previous article (*1*) we discussed many types of nuclear reactions and indicated the wide range of stability exhibited by various combinations of protons and neutrons. We shall now explore the factors which contribute to the stability or instability of a nucleus and their relation to observed nuclear phenomena.

Exploration of nuclear processes has confirmed a principle first stated by Einstein in 1905. This is the principle of mass-energy equivalence, which tells us that mass and energy are but two manifestations of the fundamental material of the universe, and together they must be conserved. The two phenomena are quantitatively related as follows:

$$\text{Energy} = \text{Mass} \times (\text{Velocity of light})^2$$

By simple arithmetic we see that the energy equivalent of one gram of matter is 2.10×10^{10} kilogram-calories, a tremendous quantity. Ordinary chemical reactions involve energies in the region of 10 to 100 kilogram calories per mol, so the mass equivalent of energy was not measurable until the tremendous energies of nuclear reactions were investigated. In the reaction

$$_4Be^9 + {}_1H^1 \rightarrow {}_3Li^6 + {}_2He^4$$

precise measurement of the nuclear masses gives the following results:

	Mass units		*Mass units*
$_4Be^9$	9.0150	$_3Li^6$	6.0169
$_1H^1$	1.0081	$_2He^4$	4.0039
	10.0231		10.0208

There is a decrease of 0.0023 mass unit, which is equivalent to 2.1 Mev. or 4.8×10^7 kg.-cal./mol in energy units. The kinetic energy of the products is greater than that of the reactants by this amount.

NUCLEAR STABILITY

The stability of a given combination of protons and neutrons is measured by its potential energy with respect to some other combination. The 29 protons (proton mass = 1.0081 m.u.)[1] and 36 neutrons (neutron mass = 1.0089 m.u.) which combine to form the nucleus $_{29}Cu^{65}$ have a total mass of 65.555 m.u., while the measured mass of the nucleus is 64.955 m.u. This mass discrepancy represents the energy of binding of the nucleus and may be used for comparison with similar figures for other nuclei to estimate relative binding energies. The possibility of radioactive decay and the energy available may be estimated by comparing its binding energy with the binding energy of possible decay products. A nucleus is stable if no exothermic reaction exists or if the transformation to a combination of nuclei of greater binding energy is a highly improbable one. Unfortunately it is not feasible to measure the masses accurately and therefore the mass discrepancy for all nuclei, even the stable ones, but a roughly quantitative theory due to Bohr and Wheeler (*2*) has been devised to calculate the binding energy of a great number of stable and radioactive nuclei which have large and roughly comparable numbers of protons and neutrons. Light nuclei (A below about 20) are not accurately treated by this theory but offer some useful illustrations of the general principles.

In the Bohr-Wheeler picture of the nucleus (frequently called the "liquid drop model") the factors contributing to nuclear binding energy and therefore to nuclear stability are qualitatively as follows:

1. The binding energies of nucleons.[2] The nucleus is considered to be analogous to a liquid drop in which the interparticle forces are very short-range, being effective only on immediate neighbors. For a first approximation these forces are assumed to be the same for protons and neutrons. Therefore this contribution to nuclear binding energy is simply proportional to the number of nucleons (A) and tends to make nuclear binding energies greater with increasing A.

2. Composition effect. This factor includes two effects. First, it makes a correction for the small difference in attractive forces of different pairs of nucleons. Unlike particles generally attract each other more strongly than do like particles. Secondly, nucleons have the property of spin, just as do extranuclear electrons, and similar pairing rules apply. Both of these effects make it pertinent to take into account the relative numbers of protons and neutrons

TABLE 1

MASS-ENERGY CONVERSION UNITS

Grams	1.00	
Atomic mass units (m.u.)	6.02×10^{23}	1.00
Ergs	9.00×10^{20}	1.49×10^{-3}
Mev.*	5.6×10^{26}	932
Kg.-cal.	2.15×10^{10}	3.58×10^{-14}

* One electron volt of energy equals the energy acquired when an electron falls through a potential difference of one volt. One million electron volts is abbreviated 1 Mev.

[1] The "proton mass" given includes the weight of one extranuclear electron. This is the usable quantity, since isotopic masses ordinarily include the weight of the orbital electrons, of which there is one for each proton in the nucleus.

[2] Protons and neutrons in the nucleus are frequently grouped together under the term "nucleons."

and the odd or even nature of their numbers. This last factor may exert a small stabilizing or destabilizing effect depending on composition (see below).

3. The surface energy of the nucleus. Here we return to the liquid drop analogy. Nucleons on the surface of the nucleus do not experience the same forces as those in the interior because they have fewer neighbors. This effect tends to lower the binding energy of the nucleus as a whole and becomes larger as the size of the nucleus increases.

4. The electrostatic energy of the nucleus. Since protons are charged particles, energy must be expended to bring them together in a nucleus. This will tend to lower the binding energy with increasing Z although this is somewhat compensated by dilution of the nuclear charge with neutrons.

The four terms mentioned above involve four constants which can be determined with the aid of the known masses and binding energies of several stable nuclei. The equation formulated on these principles permits a reasonable estimate of the binding energy of the heavier nuclei. The relative magnitudes of the various factors determining the nuclear binding energy are indicated in Table 2.

TABLE 2

NUCLEAR BINDING ENERGIES IN MASS UNITS

Nucleus	$_{29}Cu^{65}$	$_{92}U^{238}$
Atomic mass	64.955	235.084
Mass of constituents	65.555	237.018
Binding energy	0.600	1.934
Inter-particle forces	0.986	3.642
Composition	−0.016	−0.238
Surface energy	−0.241	−0.581
Electrostatic energy	−0.129	−0.889

Note the direction of change of the various factors as the size of the nucleus increases. Also note that the change in A over this interval is somewhat greater than the change in total binding energy. This means that the average binding energy per nucleon has decreased, making the heavy nucleus less stable toward various sorts of decomposition (see below).

It is beyond the scope of this article to enter into an exact mathematical description of the Bohr-Wheeler theory of the nucleus, but it is possible to point out the significance of the various factors listed above and to describe several interesting qualitative correlations with experimental observations.

NUCLEAR STABILITY VS. ATOMIC NUMBER

Let us consider the relative stability of various nuclei of constant mass number (A) and varying atomic number (Z). These nuclei are known as isobars, and beta-decay chains consist of a series of such nuclei.

If a nucleus consisted simply of a group of particles of identical properties, all isobars of a given A would have the same mass (same binding energy). The fact that protons and neutrons attract each other more strongly than do protons and protons, or neutrons and neutrons, favors nuclei of balanced composition. Thus the mass (stability) curve assumes a convex shape, with the minimum representing the least mass

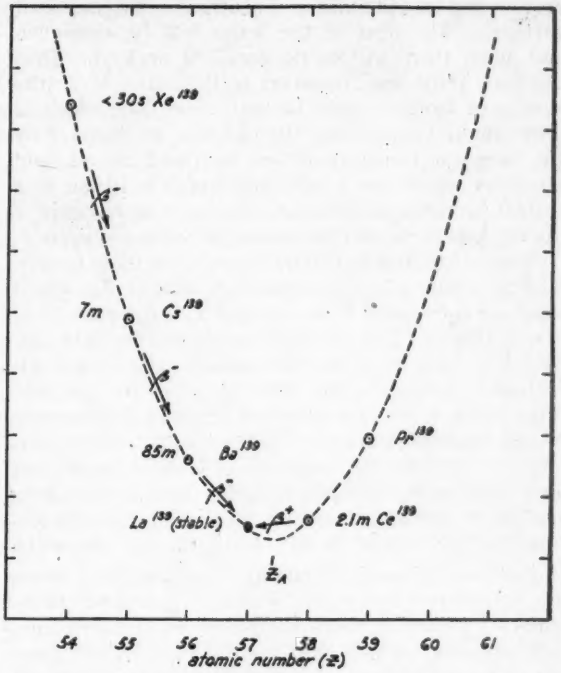


FIGURE 1.—RELATIVE STABILITY OF ISOBARS OF ODD MASS-NUMBER (139 CHAIN). VERTICAL SCALE: 1 UNIT = 1 MEV.[3]

(greatest binding energy) for the given isobaric series (see Figure 1). The slight difference in masses of the proton and neutron and the electrostatic energy term accentuate the curvature; the greater mass of the neutron will cause an increase in mass with decreasing Z (A remaining constant), but the electrostatic repulsion of protons will increase rapidly with increasing Z. The net result is a roughly parabolic curve whose minimum lies at a proton-neutron ratio less than one, due to the electrostatic energy term.

One further correction must be made. It is due to the effect of "nuclear spin" as mentioned in item 2 of the last section. Just as electrons exhibit the property of attraction by paired spins, so also do proton-proton and neutron-neutron pairs. This energy is added to the binding energy of the nucleus. In nuclei containing an odd number of protons and an even number of neutrons, there is one unpaired particle. The next member in the isobaric series will be reached by exchanging a proton for a neutron or vice versa, again leaving one unpaired particle, so that such a series (in which A is odd) will show no spin effect.

In an isobaric series of even A, suppose we start with an even number of neutrons and an even number of protons, so that all particles are paired. In going to the next member, we again exchange a neutron for a proton and now have a nucleus with an odd number of

[3] The 2.1-minute positron activity obtained by Pool and Quill (*3*) in fast neutron bombardments of cerium has been tentatively assigned mass number 139, although the short half-life seems inconsistent with the small decay energy available.

protons and an odd number of neutrons or two unpaired particles. The next in the series will be even-even and again there will be no unpaired nucleon. Thus the first, third, etc., members of this series, *i. e.*, the even-even isotopes, will lie on a parabola which is lower (more stable) than the parabola in Figure 1 by the energy of formation of one pair, and the odd-odd members will lie on a parabola which is higher (less stable) by the same amount. Figure 2 represents the appropriate parabolas for a series of isobars of even A.

Several conclusions can be drawn from these figures. The minimum of a given parabola falls at Z_A, which may not correspond to an integral Z, but for nuclei of odd A (Figure 1) there should rarely be two stable adjacent isobars, since one will usually have enough instability to decay to the other by β^+ or β^- emission. This is indeed true, for only three cases of stable neighboring isobars are known (Cd-113, In-113; In-115, Sn-115; Te-123, Sb-123), and one of each of these pairs may well be radioactive, decaying with a very long half-life to the other. Such a situation occurs for Re-187, Os-187; Rb-87, Sr-87; K-40, Ca-40; where the underlined isotope shows long-lived radioactivity. Since the neighboring isobars in the even A groups will be on different parabolas, there may be several stable isobars, not adjacent, as indicated by Figure 2 Also, there are no known stable nuclei above $A = 14$ containing an odd number of neutrons and an odd number of protons, since these all lie on the upper parabola and will always be unstable with respect to some nucleus on the lower parabola, reached by β^- or β^+ decay.

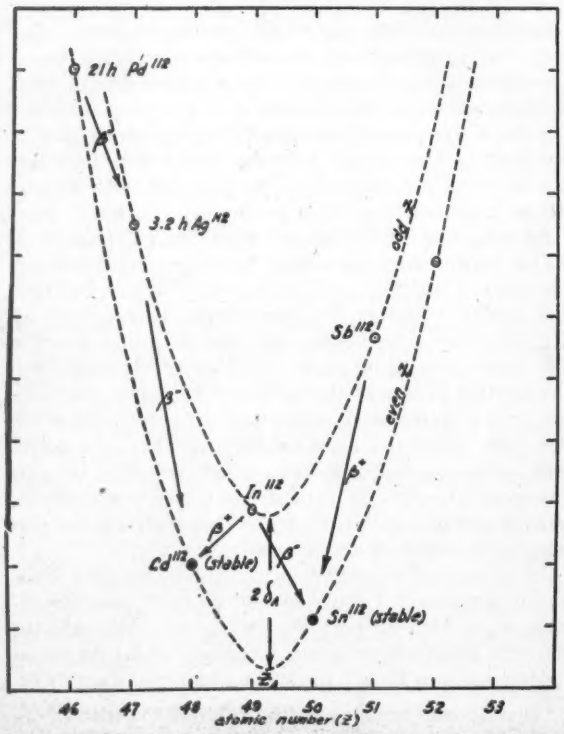


FIGURE 2.—RELATIVE STABILITY OF ISOBARS OF EVEN MASS NUMBER (112 CHAIN). VERTICAL SCALE: 1 UNIT = 1 MEV. δ_A = ENERGY OF FORMATION OF ONE SPIN PAIR.

The two generalities stated in the preceding paragraph shed some light on the question of the existence of stable isotopes of elements 43 and 61. Since they contain an odd number of protons, we can dismiss as unstable the isotopes which also contain an odd number of neutrons. Examination of the isotopes which would contain an even number of neutrons reveals that in all cases a neighboring element has a stable isobar. This means that if stable isotopes of 43 or 61 exist, they must have neighboring stable isobars, a very rare and unlikely circumstance.

The decay energies for isobaric series can be estimated from these curves, being simply the difference in stability of the parent and daughter nuclei. As a general rule the half-life of a nucleus is a measure of its instability, short half-lives being associated with energetic decays and vice versa. For the sake of simplicity and because of greater availability, only the half-lives of the isobaric nuclei are given in Figures 1 and 2. For nuclei of odd A (Figure 1) we find decay chains of decreasing energy as the nucleus of maximum stability is approached. For nuclei of even A (Figure 2) we find decay chains of alternating energies, with the possibility of alternate paths of decay. Decays involving simultaneous emission of two electrons or positrons are apparently so improbable as to be unobservable.

NUCLEAR STABILITY VS. MASS NUMBER

It is possible to construct a parabola, such as those described in the preceding section, for each mass number except those at the beginning of the periodic system. These would form a three-dimensional figure representing the relative stability of all these nuclei.

Cross sections of this figure along an axis of constant atomic number (Z) furnish information about the relative stability of a series of nuclei known as isotopes. Alternating stabilities due to the spin effect are again observed. Isotopic series of odd Z, containing an unpaired proton, will be less stable than series of even Z, in which all protons are paired. This effect makes stable nuclei of even Z considerably more abundant. In each type of series, however, there will be an alternation in stability due to the odd or even nature of the number of neutrons. While in series of even Z there may be several stable adjacent isotopes, in a series of odd Z this alternation eliminates stable adjacent isotopes of odd A above 7.

A useful quantity in the study of nuclear stability is the *average binding energy per nucleon*. As A increases, this varies erratically up to $A = 20$, then regularly increases, reaching a maximum of about 8.9 Mev. per nucleon at $A = 70$. From there to the end of the periodic table it slowly decreases to a value of about 7.6 Mev. per nucleon at mass numbers around 235 (see Figure 3). While this figure is computed from the values for the stable isotopes only, the general character of the curve will not be greatly different for changing values of the n/p ratio.

It is apparent that if a nucleus above $A = 100$ were to divide into two approximately equal parts, the nucleons of the resulting nuclei would have a greater average binding energy. In other words, the process would be exothermic. The fission of a nucleus of $A = 230$ into approximately equal parts will change the average binding energy per nucleon from 7.6 Mev. to 8.6 Mev. Thus some 200 Mev. of energy will be liberated when one nucleus undergoes fission. Note that the two fragments produced in such a fission reaction will together have about 13 more neutrons than stable isotopes of the same Z. This makes them highly radioactive, each one of the pair emitting beta particles until stable neutron-proton ratios are reached.

It would seem as though fission of ${}_{92}U^{235}$ and similar isotopes, obviously an exothermic process, ought to proceed spontaneously. Yet the act of fission is initiated, in the example given, essentially only when a neutron is captured by the nucleus. The explanation is indicated by further consideration of the liquid drop model of the nucleus. The most stable form for such a body is a sphere, and it takes work to deform it, due to the increased surface energy. Thus for fission there is an energy hump, the deformation of the nucleus, which must be surmounted before the exothermic process can proceed. The capture of a neutron supplies the excitation needed.

APPLICATIONS TO OTHER NUCLEAR REACTIONS

In a previous article (*1*) the dependence of certain nuclear reactions on the energy of the reacting particles was vaguely indicated. We can now explain some of these effects in more detail by considering the energy balance in such reactions. A given mode of reaction will become important only when the process is exothermic, *i. e.*, when the sum of the masses and energies of the reactants is greater than the sum of the masses of the products.

The (n,γ) reaction can occur with neutrons of vanishingly small energies because the reaction is always exothermic by the binding energy of a neutron. The general reaction is

$$\underset{1.0089}{{}_zX^A} + {}_0n^1 \rightarrow {}_zX^{A+1} + \gamma$$

Examination of any pair of adjacent stable isotopes above $A = 20$ shows that their masses differ by about 1.001 mass units or less. This means that there is in general a decrease in mass of about 0.008 mass unit in an (n,γ) reaction. The 7 Mev. of energy thus released appears as several hard gamma rays. Conversely, in order to eject a neutron from the nucleus—(γ,n) reaction—about 7 Mev. of energy must be supplied. This quantity is smaller for some of the lighter nuclei and can be readily calculated. An $(n,2n)$ reaction requires that a second neutron be ejected and so will require fast neutrons to supply the extra 7 Mev.

The general equation for an (n,p) reaction is

$$\underset{1.0089}{{}_zX^A} + {}_0n^1 \rightarrow {}_{z-1}X^A + \underset{1.0081}{{}_1p^1}$$

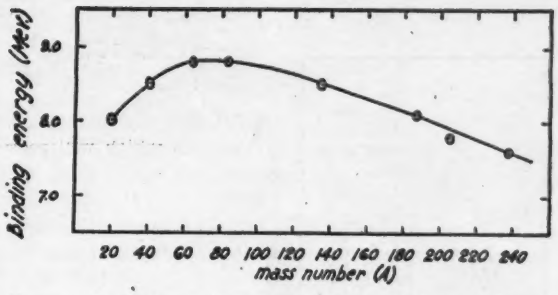


FIGURE 3.—BINDING ENERGY PER NUCLEON FOR STABLE ISOTOPES.

Therefore, if the mass of ${}_{z-1}X^A$ is not more than 0.0008 mass unit greater than the mass of ${}_zX^A$, the reaction will be exothermic for neutrons of any energy. If we start with a stable nucleus, we see from the parabolas of Figures 1 and 2 that this will depend on the location of the particular nucleus concerned. In addition, the (n,p) process must compete with (n,γ) and other low-energy reactions. Therefore no general prediction can be made and the efficiency of (n,p) reactions is found to vary widely.

The (n,α) reaction is exothermic over a wide range of nuclei, since the 7 Mev. of energy given to a nucleus by the capture of a neutron is usually more than enough to induce decay.

$$\underset{1.0089}{{}_0n^1} + {}_zX^A \rightarrow {}_{z-2}X^{A-3} + \underset{4.0039}{{}_2He^4}$$

Examination of a few stable isotopes indicates that ${}_zX^A$ usually has a mass more than 3.995 units greater than ${}_{z-2}X^{A-3}$, so the reaction will be exothermic even with slow neutrons. The same conclusion may be reached by a consideration of alpha decay, which is endothermic by less than 7 Mev. over much of the periodic table. Under such circumstances the neutron capture furnishes more than enough energy to make the over-all reaction exothermic. The (n,α) reaction must compete with (n,γ) and is usually the less important of the two.

Reactions with charged particles can be treated in a similar fashion, except that the coulombic repulsion must also be taken into account. The (d,p) reaction is a useful and interesting case where the practical threshold energy is below that predicted for capture of a deuteron. The over-all reaction is equivalent to the (n,γ) reaction and is exothermic as explained above. Apparently the deuteron is polarized as it approaches the nucleus and only the neutron actually enters, thus lowering the energy barrier for the reaction.

ACKNOWLEDGMENT

The author thanks Dr. Charles D. Coryell for suggesting and aiding in the preparation of this article.

LITERATURE CITED

(1) WILLIAMS, R. R., JR., THIS JOURNAL, **23**, 423 (1946).
(2) BOHR, N., AND J. A. WHEELER, *Phys. Rev.*, **56**, 428 (1939).
(3) POOL, M. L., AND L. L. QUILL, *ibid.*, **53**, 437 (1938).

Out of the Editor's Basket

AMONG the many new articles which will soon be on the market for the consumer are new light weight products of various sorts: Magnesium griddles covering two range burners which are said to heat evenly to the very edge in two minutes; all aluminum coffee percolators, asbestos-insulated for quick heat, with heat-resistant and nonburnable handles and a cover that locks on tight; folding kitchen stepstools and ladders; light-weight folding irons and ironing boards to fit into a travelling bag; wardrobes with no screws or bolts; clothes hampers; mail boxes wide enough for magazines and fitted with locks; hot plates to save food and work; a six and one half-pound vacuum cleaner with finger-tip control; a many-purpose anodized aluminum clip; and a combination tool for the garden which is used as hoe, rake, cultivator, and weed puller.

A high-quality orange powder from the juice of fresh oranges is another one of the "newies." It is a dehydrated orange juice containing all the original and natural ingredients except the water.

A new process has recently been reported for the preservation of fruits and vegetables. It involves the use of high-frequency currents in reducing moisture content beyond that which is possible by ordinary means of dehydration, thus materially extending the keeping qualities of the dehydrated products.

A mercury dry cell for batteries has been developed which is welcomed for use in hearing aids because of its reduced weight. The mercury dry cell also will be widely used in flashlights. The added life and capacity will serve many purposes.

A new waterproof printing paper has been developed which will not disintegrate in water, can be boiled, and contributes to the making of permanent records. An acid- and chemical-resistant paper is washable and resists hard rubbing even when wet—good for blueprints, maps, and charts. A specially creped oil and greaseproof paper, in addition to protecting against dust, dirt, corrosion, and rust, has strength and stretches in more than one direction, making it especially useful for wrapping metal parts and supplies.

Chemical Exposition

New discoveries, new ideas, new applications, and new developments in industrial chemistry will be opitomized in an exhibit appropriately styled, "The Chemical Trail Blazers," which will be a feature display at the Fourth National Chemical Exposition to be held September 10 to 14 at the Coliseum in Chicago.

The exhibit will be a major development of a comparatively small collection of sketches, panels, and specimens shown under the same title at the last National Chemical Show in the same building in 1944. It will be presented on a more elaborate, more comprehensive, and broader scale this year.

It is designed to be of interest to the thousands of chemists, scientists, and others who will attend the national convention of the American Chemical Society to be held simultaneously and with which the chemical show is closely integrated this year. As heretofore the exposition is sponsored by the Chicago Section of the A.C.S.

Iron Powder

A new method of preparing iron powder directly from pulverized iron ore by reducing the ore at low temperatures is described in a patent application filed in Germany by the Kaiser Wilhelm Institut für Eisenforschung, an iron research institute in Duesseldorf. Copies of the patent application (text in German) are on sale by the Office of Technical Services, Department of Commerce.

The German process makes use of the discovery that the size of iron ore particles remains unchanged if the ore is reduced at comparatively low temperatures (600 to 750°C.). Thus the particle size of powdered iron can be predetermined through pulverization of the iron ore. It is emphasized in the patent application that pulverization can be accomplished much more easily and economically before reduction since ore can be broken up more readily than soft iron.

Reduction of the pulverized ore should be carried out in several stages, according to the Germans. This permits removal of impurities between stages. As reduction proceeds, the pulverized material shows an increasing tendency to stick to the furnace walls or to form little pellets in the rotary furnace. The temperature in the final stages therefore should range between 600 and 750°C. as compared with the temperature of 700 to 880°C. permissible in the early stages.

Fungus on Plastics

Plastics vary in their susceptibility to fungus growth because their inorganic constituents generally are resistant, while their organic components are nonresistant, to such growth, according to a recent OSRD report.

Samples and components of vinyl type plastics were inoculated with 32 cultures representing 20 species of tropical fungi. The results showed that wholly synthetic phthlate, vinyl resin, phosphate plasticizers, and inorganic pigments and fillers do not support fungus growth, and that plasticizers or lubricants of animal or vegetable origin do support such growth.

Research in fungus preventives revealed that high-quality, moisture-proof varnish protects phenol-formaldehyde cotton base laminates as well as any of the fungicidal finishes tested.

CO_2 Pipe Line

Probably the world's most unusual pipe line is one which carries a normally gaseous material—carbon dioxide—in a refrigerated pressurized form, directly from producer to consumer. The carbon dioxide, previously delivered by truck or rail in the form of dry ice or in the form of gas in heavy and bulky pressure tanks, is now pumped as a liquid under pressure from the plant of the producer into storage tanks of Walter Kidde and Company, Inc., Belleville, New Jersey. The pipe line runs more than a quarter of a mile from plant to plant. Although largely underground to benefit from normal insulation characteristics of the earth, approximately 200 feet of pipe have been placed above the ground.

The pipe is standard two-inch steel with welded joints. In order to keep the carbon dioxide at a low temperature and to prevent condensation on the outside of the pipe, it is well insulated with asphalt paint and two layers of roofing (tar) paper in addition to the natural ground insulation. One section of the pipe line, which runs under a railroad siding, was installed by inserting it through a large 14-inch steel pipe that had previously served as a steam main but later abandoned. This section, as well as the 200-foot overhead section, have been additionally insulated with eight inches of cork.

CO_2 PIPE LINE

Gas Analysis Recorder

An unusual gas analysis recorder, operating on the infrared absorption principle, was developed by the Germans, according to a report on the industrial processing instrument industry in Germany. The gas analysis recorder, known by the trade name "Uras," was developed and built at the I. G. Farben plant in Oppau. It consists of a radiation source in the form of helices of nickel-chrome resistance wire, filter, reference, and analysis chambers made of glass and gold spattered inside to prevent loss of radiation, a microphone unit, and electrical circuits.

When a gas is passed through the chambers, the infrared light is selectively absorbed by the gases. The microphone responds to differences in the heating effect of radiation coming from the reference and analysis chambers. The output of the microphone is amplified, rectified, and applied to a millivolt-meter recording instrument.

Industrial processing instruments were less important in Germany's war effort than in the United States', according to the report. Measuring instruments were widely used, but control was principally by hand operation.

The investigators conclude that the Germans were 10 to 15 years behind American industry in the development of automatic controls. This was due in part to the widespread use of the "batch" manufacturing method in Germany as compared with the "continuous" method in the United States. Also, the availability of low-cost labor limited demand for automatic controlling devices.

Controlling Fungi

Methods developed during the war for controlling fungus growth on binoculars, periscopes, telescopes, and other optical instruments are discussed in eight reports now on sale by the Office of Technical Services, Department of Commerce.

The reports describe research carried out in 1944 and 1945 at the Universities of Pennsylvania and Pittsburgh under contract with the Office of Scientific Research and Development. The purpose of the research was to assist the armed forces in the preservation of equipment in the tropics.

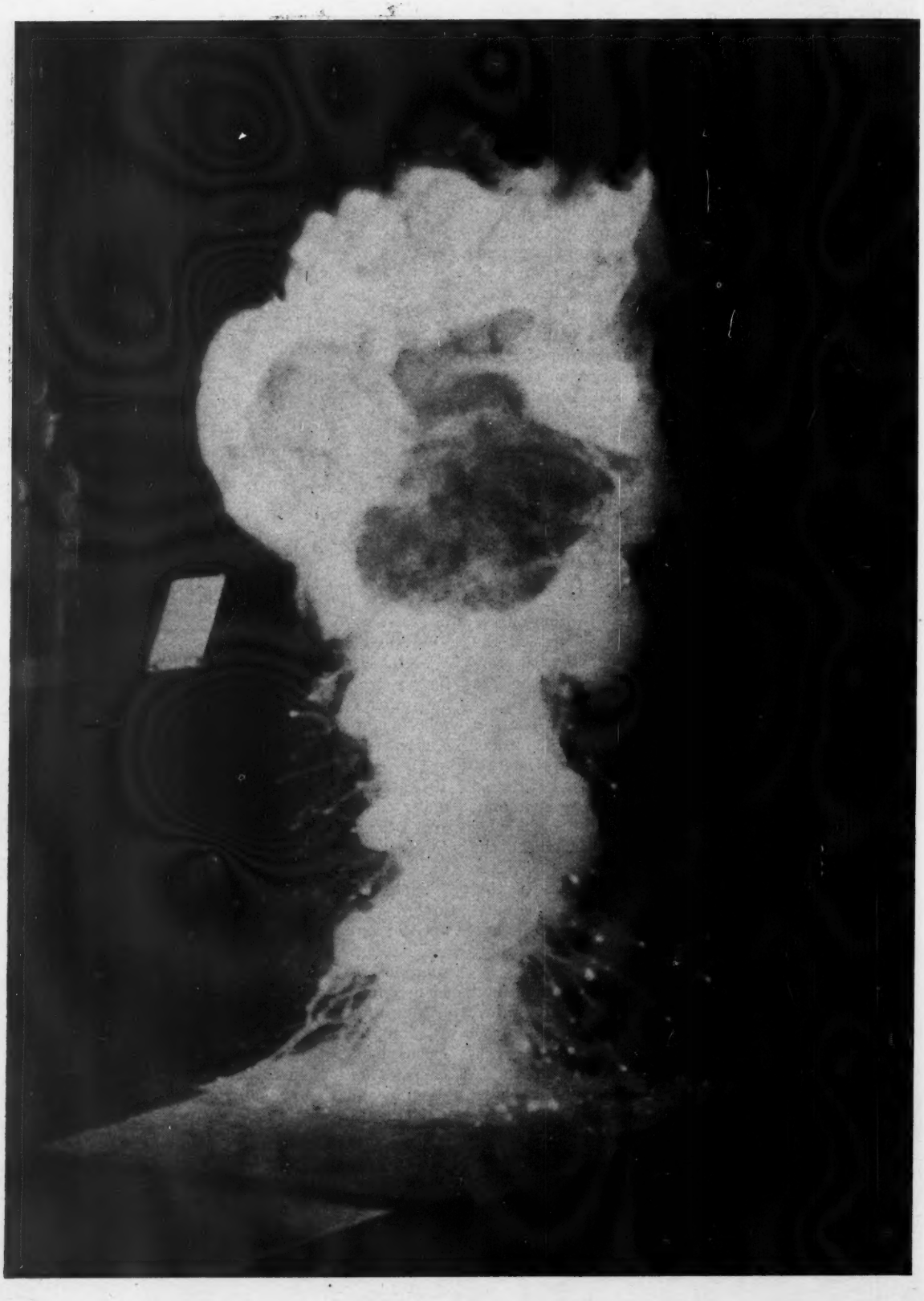
Salient findings of the researchers include the following:

Glass surfaces on optical instruments may be decontaminated by cleaning with a 95 per cent ethyl alcohol solution. A 70 per cent ethyl alcohol solution should be used for the stripped metal case.

Meta cresol acetate effectively inhibits fungus growth. It should be used in the form of ethyl cellulose blocks enclosed in metal capsules with small openings. The capsules are attached to the inner surface of the instrument by adhesives or soldering.

Hermetic sealing of the instrument with a thermoplastic compound to which paranitrophenol has been added gives further protection against entry of spores, mites, or other materials supporting mold growths.

Optical instruments should be stored in air-conditioned warehouses. If this is impossible, specially constructed dry chests may be used instead.



Cracking Methane

The Germans developed processes for cracking methane by partial combustion with oxygen or air into hydrocarbon products suitable for chemical purposes.

Two processes for the production of synthesis gases by partial combustion are outlined in the report: (1) a continuous process employing a nickel catalyst, and (2) an intermittent or regenerative cycle operation employing steam without a catalyst.

The nickel catalyst method can be used to produce either an ammonia synthesis gas mixture or various carbon monoxide-hydrogen mixtures for the methanol, isobutanol, Fischer-Tropsch, and other syntheses. In making gas for the ammonia synthesis, part of the oxidation or combustion oxygen is obtained by using air instead of pure oxygen to the extent necessary to yield nitrogen and hydrogen in a 1:3 ratio in the final gas.

For acetylene production by partial combustion, the Germans use essentially the same method as for synthesis gas production, outlined above. The main differences between the methods are that for acetylene production only relatively pure methane or ethane is used, and gases coming out of the combustion chamber are immediately quenched with a direct water spray. No catalyst is used.

The highest acetylene concentration obtained commercially through partial combustion is about 10 per cent. The usual range is 7 to 9 per cent.

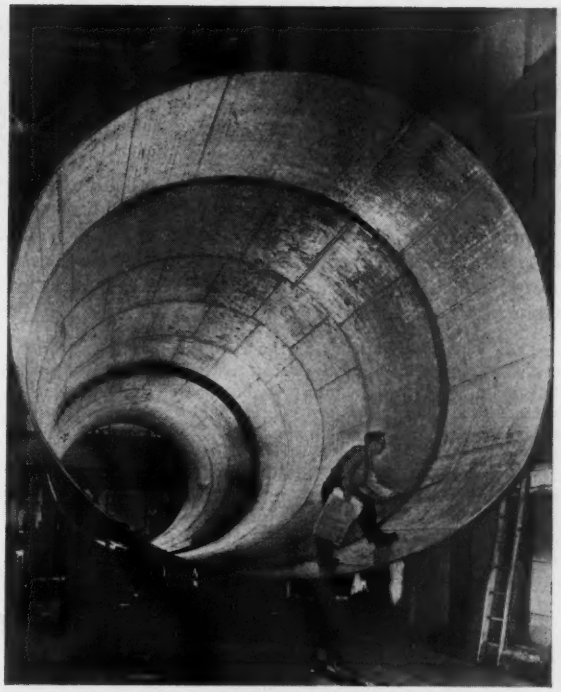
The I. G. Farbenindustrie plant at Ludwigshafen, the Lurgi Company at Frankfurt, and the H. Koppers Company at Essen early in the war began work on the problem of cracking pure methane and methane in coke-oven gas by partial combustion with oxygen or air for the production of hydrogen, hydrogen-carbon monoxide mixtures, hydrogen-nitrogen mixtures, and acetylene. Before the war, in spite of the scarcity of hydrocarbons in Germany, methane cracking had not been developed commercially.

For Authors

Two articles which appeared recently in the *American Journal of Physics* may be of interest to our readers and potential authors. Their respective titles are "Preparation of Graphs for Physical Papers" and "Technical Writing and Editing: Source Literature; Elementary Textbooks." We strongly recommend their contents. Reprints may be had from the *American Journal of Physics*, Wabash College, Crawfordsville, Indiana.

To the left: PHOTOGRAPH OF THE EXPLOSION OF ZINC AND SULFUR. The flash was produced by heating a mixture of zinc dust and sulfur. Approximately four grams of zinc dust and two grams of sulfur were used. The elements were mixed and heated on a large asbestos board by directing the flame of a Bunsen burner downward upon the mixture. The flash is often started by stirring or touching the mixture. For this purpose use a long rod such as the combustion spoon. Keep at least arms length away from the mixture while heating it. Note the hand of the experimenter to the right of the mushroom and the 500 ml.-reagent bottle to the left.

The photograph was taken by George Richards using a Contax camera with a *f*-2 Carl Zeiss lens on an Eastman plus-X film. The exposure was *f* 11, 1/100 of a second.



THIS FACTIONATING TOWER, WHICH WEIGHS APPROXIMATELY 160 TONS, IS LINED WITH STAINLESS STEEL.

Tower of Strength

The refinery fractionating tower shown above, said to be the largest ever fabricated in a shop, is 16 feet in diameter and more than 100 feet long. It was lined with stainless steel to withstand the high temperatures and corrosion encountered in processing petroleum products. Thin sheets of stainless steel were sufficient for this inner wall, since the metal will retain its strength and corrosion resistance at high temperatures. The tower was built by the A. O. Smith Corporation of Milwaukee, Wisconsin.—Courtesy of *Electromet Review*.

Streptomycin

Preliminary plans for limited commercial distribution of streptomycin after September first have been outlined by Civilian Production Administration officials. The plan will follow that used with penicillin. Streptomycin will be issued to selected hospitals throughout the country, and they will act as depots for their area. The amounts of streptomycin that will be distributed and the particular hospitals have not been determined as yet.

Although CPA reported that the June production of streptomycin, as indicated from preliminary reports, was lower than expected, it is felt that a sufficient quantity would be on hand for the inauguration of the proposed plan on September 1, 1946. May production of streptomycin was 38,750.9 grams. Treatment of individual cases of tuberculosis for the minimum period of three months costs about $4000 for the drug.

Selective Service Not Dead

Recent developments in Selective Service gave cause for optimism. As a result of intervention of the Office of War Mobilization and Reconversion restrictions on deferment have been relaxed to the extent that *bona fide* graduate students in science and engineering, as well as research workers and teachers in these fields, may be deferred. Nevertheless, continued pressure seems advisable to maintain the gains. The following is quoted, in part, from an editorial in the *Pan Tech News*, official publication of the Technical Societies Council of the Kansas City area.

There is naturally a fear that the exemption of students of science and engineering and the exemption of engineers and scientists in industry might be interpreted as class favoritism. Rather than class favoritism this procedure would be a strong step forward in national health and public welfare.

The war has brought an appreciation of research to all people. Nations which hitherto gave little or no attention to research will soon be seriously launched on both educational and industrial research programs. Their enthusiasm for their newly found means of improving the conditions and earning power of the common man may very well drive them to greater heights than we may achieve because of our complacent acceptance of the ever-present benefits of research.

It is the patriotic duty of every employer to put forth all possible effort to avail himself of the meager provisions to protect scientific workers from being drafted. Our country needs the research, development, and engineering service of every qualified man. It has been recently reported from good sources that Russia is spending more than one per cent of her gross national income on research and development work. Our country is spending about one-third of one per cent at the present time.

Perhaps we may be so much more efficient than Russia that our efforts will produce the same results as their three-time greater effort but we can be sure of staying ahead in world competition only if every available effort is put forth for industrial and scientific development. Shortsightedness on the part of legislators must be overcome by diligence on the part of American employers.

Motion Picture

The National Carbon Company has issued a motion picture, entitled "Carbon—Black Treasure," a 16-mm. Kodachrome story of the manufacture of carbon electrodes and other products. For information on obtaining it, write the Acheson Works, Niagara Falls, New York.

LETTERS

To the Editor:

The two papers by Dr. R. K. McAlpine in the June number of your journal interested me because they represent subjects in which I have been interested for many years. The scheme for separating and identifying cobalt, nickel, zinc, and manganese is good, except when phosphate or similar acid is present. Then the alkaline earths and magnesium may be found in the precipitate produced by ammonia in the presence of ammonium chloride. Chromium also carries down many bivalent ions, and I have known students to miss magnesium in the analysis of magnesium chromate. Most texts fail to mention the likelihood that insoluble *chromites* of alkaline earths and magnesium may be precipitated with Group III.

In attempting to make practical use of the half-reactions in a table of Oxidation Potentials, we often forget that the concentration of every ion is assumed to be molar, and we also forget that these equations are *reversible* and follow the law of mass action. Thus a reaction, such as

$$H_3AsO_4 + 2I^- + 5H^+ \rightleftharpoons 4H_2O + I_2 + As^{+++}$$

which is the sum of two half-cell reactions, will take place quantitatively in the direction left to right when the solution is strongly acidic with hydrogen chloride, but will go completely in the opposite direction if the solution is neutral and contains a buffer salt, such as sodium bicarbonate or disodium phosphate.

The oxidation and reduction reactions of manganese ions are interesting because the manganese in these ions can contain bivalent, trivalent, sexivalent, or septavalent manganese, or the manganese may be precipitated as hydrated dioxide, H_2MnO_3, which can be called manganous acid.

About 48 years ago when I was an assistant in the laboratory of analytical chemistry, I heard a lecture in which the professor stated that in the filtrate from a basic acetate separation, it is very satisfactory to precipitate manganese as $MnO_2 \cdot H_2O$ by means of bromine water but, he added, "The manganese will *not* precipitate if any considerable quantity of ammonium salt is present although I cannot explain why." So, in the hope of learning something that my chief did not know, I studied the literature carefully and found that many analytical chemists knew that to precipitate manganese as $MnO_2 \cdot H_2O$ in an ammoniacal solution, it is necessary to keep adding small portions of bromine with alternate portions of ammonia. Then, with a little practice, it is easy to learn the trick of getting complete precipitation. At that time every student in a class of about 60 was supposed to carry out four basic acetate separations at volumes of about one liter. Almost half of the students were obliged, for one reason or another, to repeat the analysis, and they were all a bit bored by the procedure. Many of them tried to avoid the basic acetate procedure and used the ammonia separation which, as the contents of bivalent manganese, calcium, and magnesium were quite low in the samples of spathic iron ore to be analyzed, gave results which were quite satisfactory; but when the directions were followed that were correct for the basic acetate procedure, the manganese failed to precipitate on boiling with bromine water. We used the procedure from some time in the early nineties until about 1917, so that

the precipitation of manganese by bromine was constantly in our minds. The fact that the bromine oxidized ammonia or ammonium ion instead of the manganese was apparent, but unfortunately our text on qualitative analysis contained the erroneous statement that bromine or chlorine reacted with ammonia water to form hypochlorite and chloride. The author knew that sodium hydroxide and chlorine gave NaClO and $NaClO_3$, for he taught freshman chemistry one year and reasoned that NH_4OH would react likewise. It was not until about 1900 that I realized that the reactions

$$8NH_3 + 3Cl_2 = N_2 + 6NH_4Cl$$
$$2NH_4^+ + 3Cl_2 + 8OH^- = N_2 + 6Cl^- + 8H_2O$$

expressed the truth. At that time I had been promoted from the laboratory of advanced quantitative analysis to the more interesting work of *qualitative* analysis. However, in 1916 I was teaching both kinds of analysis and found that our laboratory notes still failed to explain the manganese precipitation satisfactorily, and since some one else had charge of the course, it was necessary for me to *prove* that my theory was right. At that time S. G. Simpson (now a professor of analytical chemistry at M.I.T.) was a third-year student, and he carried out some quantitative experiments for me. The results were so interesting that sometimes I noticed several of his classmates watching him. Briefly, this is what he found.

In the presence of sodium acetate, the reaction

$$2NH_4^+ + 3Br_2 + 8C_2H_3O_2^- = N_2 + 6Br^- + 8HC_2H_3O_2$$

takes place more readily than the reaction

$$Mn^{++} + Br_2 + 3H_2O + 4C_2H_3O_2^- = MnO_2 \cdot H_2O + 4HC_2H_3O_2 + 2Br^-$$

but, if sufficient acetate is present, the manganese will be precipitated after all of the ammonium ion has been oxidized to nitrogen. The evolution of nitrogen takes place very readily, and there is no evidence of the formation of any intermediate nitrogen compound such as chloramine, hydrazine, or hydroxylamine. If an excess of sodium acetate is *not* present, the solution becomes acidic whereby both oxidizing reactions stop; and if considerable ammonium salt and little manganous ion is present, it is likely that precipitated $MnO_2 \cdot H_2O$ will dissolve.

The theory advanced by Dr. McAlpine that with sodium hypochlorite as the oxidizing agent, some hydrazine is formed which will reduce any $MnO_2 \cdot H_2O$ and cause it to dissolve is interesting and plausible. In fact, he has shown that by adding hydrazine, it is easy to dissolve the manganese precipitate. He does not, however, actually prove that hydrazine is formed but relies upon the work of Raschig, who showed that from 200 ml. of 20 per cent ammonia, 5 ml. of glue, and some freshly prepared sodium hypochlorite solution, it is possible to prepare 6 g. of $NH_2 \cdot NH_2 \cdot H_2SO_4$, which corresponds to a yield of about 4 per cent. Unless the glue is added, the end products are NH_4Cl, HCl, and N_2. Raschig assumes that the first product in the oxidation of ammonia by hypochlorous acid is chloramine, NH_2Cl.

Now I have no means of knowing that Dr. McAlpine's explanation is incorrect, but I merely wish to point out that it is not necessary to assume the formation of hydrazine. In one of his experiments he used a solution containing 10 mg. of Mn^{++} and 900 mg. of NH_4 (counting the ammonia as well as the added ammonium chloride). Of the reactions

$$Mn^{++} + OCl^- + H_2O \rightleftharpoons MnO_2 + Cl^- + 2H^+$$

and

$$2NH_4^+ + 3OCl^- \rightleftharpoons N_2 + 3Cl^- + 2H^+ + 3H_2O$$

it is certainly true that neither will take place unless the solution is kept at a pH not much lower than 7. The oxidation of the ammonium ion will take place more readily than the oxidation of the manganous ion, and when the oxidation of the NH_4^+ is complete, the solution may be at a pH below 7, so that the relatively small quantity of Mn^{++} cannot be oxidized. If at any time a little MnO_2 is formed, we would expect it to redissolve.

I should like to add also that after a sodium peroxide fusion, it is possible at times to discover all of the changes noted by Dr. McAlpine with respect to manganese. I have seen the aqueous extract of the melt contain $MnO_2 \cdot H_2O$. I have also seen a green solution which may be due to trivalent manganese or even sexivalent manganese as manganite. I have more than once noticed the formation of permanganate. The Volhard reaction which has been used so much in quantitative analysis may be expressed

$$3Mn^{++} + 2MnO_4^- + 7H_2O \rightleftharpoons 5(MnO_2 \cdot H_2O) + 4H^+$$

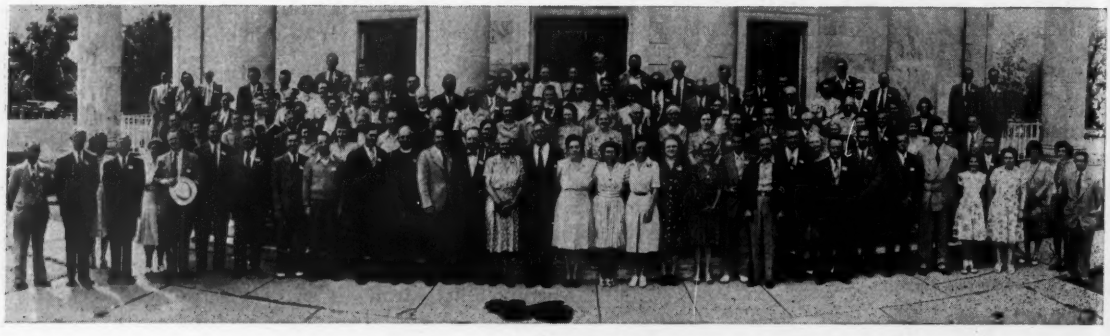
It is perfectly conceivable that Mn^{++} and MnO_4^- can be formed by the reaction's taking place from right to left, but I have never been able to discover the right conditions for making it and have only occasionaly noted the formation of MnO_4^-. In experiments with 10 mg. of Mn^{++}, one would not expect *much* MnO_4^- to be formed, although the possibility of quadrivalent manganese's reacting to form a mixture of bivalent and septavalent manganese by the reverse of the Volhard reaction would not seem strange at all.

I hope that no one who reads these remarks will imagine that I wish to discredit anything that Dr. McAlpine has said in his two interesting papers. I merely wish to suggest another possible explanation. It was my hope when the JOURNAL OF CHEMICAL EDUCATION was started some 23 years ago, that we would have some polemical discussions concerning chemical theory and methods of instruction. I taught analytical chemistry for 41 years, but I am reasonably certain that no one else has taught it the way I did, and I certainly would hate to teach the subject the same way that some of my friends do. It is a sign of healthy imaginations if we disagree concerning either chemical theory or methods.

WILLIAM T. HALL

ROCHESTER, MASSACHUSETTS

Report of the NEW ENGLAND ASSOCIATION *of* CHEMISTRY TEACHERS



EIGHTH SUMMER CONFERENCE

THE Eighth Summer Conference of the N.E.A.C.T. was held at Middlebury College, Middlebury, Vermont, August 19–24, with 175 members and guests in attendance. Of the 175 registered at the Conference, 115 were from New England and the remaining 60 were from a total of 16 other states. The Association was particularly fortunate this year to be able to use the excellent and attractive campus of Middlebury College, located as it is in the beautiful Champlain Valley, an ideal vacation spot.

The wartime plan of holding the Conference over a long week-end was abandoned, and the original schedule of Monday through Saturday was again followed this year. In addition to the many addresses there were motion pictures on chemical subjects before each evening address and social hours following, a picnic at Lake Dunmore on Wednesday afternoon, and a trip to one of the quarries of the Vermont Marble Company on Thursday afternoon. At the social hour on Thursday evening, Elbert C. Weaver, on behalf of the Association, bade farewell and extended our best wishes to Norris W. Rakestraw, a past president of the Association, who is leaving New England after 20 years of teaching and active participation in the affairs of the Association.

The Conference program follows:

Monday evening (Chairman: Ina M. Granara, Simmons College)—"Welcoming Address," Samuel S. Stratton, President, Middlebury College; "The Size and Shape of the Universe," Charles H. Smiley, Brown University.

Tuesday morning (Chairman: Raymond E. Neal, Simmons College)—Electrochemistry Symposium: "Introduction," William B. Meldrum, Haverford College; "Galvanic Cells and E. M. F.," Frank T. Gucker, Jr., Northwestern University; "Teaching Science to Science Talented Youth in High School," Morris Meister, Bronx High School of Science.

Tuesday afternoon (Chairman: Howard A. Smith, Milton High School)—Electrochemistry Symposium: "Electrolysis," John A. Timm, Simmons College; "Industrial Catalysis," Ben B. Corson, Mellon Institute.

Tuesday evening (Chairman: Paul F. Stockwell, Brattleboro High School)—"Importance of Chemical Education," Avery A. Ashdown, Massachusetts Institute of Technology.

Wednesday morning (Chairman: Norris W. Rakestraw, Editor, JOURNAL OF CHEMICAL EDUCATION)—Electrochemistry Symposium: "The Mechanism of Oxidation-Reduction Reactions," William B. Meldrum, Haverford College; "Round Table Discussion," Leader, John E. Cavelti, Allegheny College; "Chemistry in Life Insurance," Sidney H. Roberts. Aetna Life Insurance Company.

Wednesday evening (Chairman: P. Conant Vote Middlebury College)—"Mining the Air and the Ocean," John E. Cavelti, Allegheny College.

Thursday morning (Chairman: Elbert C. Weaver, Phillips Academy)—Colloid Symposium: "Introduction," Ernst A. Hauser, Massachusetts Institute of Technology; "The Application of Colloid Chemistry to the Manufacture of Inflated Articles," Langley W. Ison, Dewey and Almy Chemical Company; "Resin Curing by Polymerization Reactions," Edward L. Kropa, American Cyanamid Company.

Thursday evening (Chairman: Dorothy W. Gifford Lincoln School)—"Recent Experiences in Germany," Roger Adams, University of Illinois.

Friday morning (Chairman: Rev. Bernard A. Fiekers, S.J., Holy Cross College)—Colloid Symposium: "The Development and Application of the Electron

Microscope," Charles J. Burton, American Cyanamid Company; "The Development and Application of Ultramicroscopy with Incident Light, "Desiree Le Beau, Midwest Rubber Reclaiming Company.

Friday afternoon (Chairman, Lawrence H. Amundsen, University of Connecticut)—Colloid Symposium: "The Colloid Chemistry of Clay Minerals," Ernst A. Hauser, Massachusetts Institute of Technology; "Round Table Discussion," Leader, Ernst A. Hauser; "New Alloys in Steel," Joseph F. Libsch, Lehigh University.

Friday evening (Chairman, Grover C. Greenwood, Harding High School, Bridgeport)—"A Chemist in a G. I. University," Andrew A. Scarlett, Dartmouth College.

Saturday morning (Chairman, Helen W. Crawley, Walnut Hill School)—"Biotin, Its Structure, Synthesis, and Stereochemistry," Stanton A. Harris, Merck and Company; "Silicones," Francis J. Norton, General Electric Company.

The high points of the Conference were, perhaps, the symposia on electrochemistry and on colloids, led respectively, by William B. Meldrum and Ernst A. Hauser.

The Conference Committee consisted of Ina M. Granara, Simmons College, *Chairman;* Otis E. Alley, Winchester High School, *Secretary;* Helen W. Crawley, Walnut Hill School, *Treasurer* and *Registrar;* Lawrence H. Amundsen, University of Connecticut; John K. Bodel, Jr., Hotchkiss School; Millard W. Bosworth, Vermont Academy; Gertrude T. Eastman, High School of Commerce, Worcester; Rev. Bernard A. Fiekers, S.J., Holy Cross College; Ernst A. Hauser, Massachusetts Institute of Technology; Harriet S. Hemenway, Simmons College; George D. Hearn, Worcester; Phebe S. Hoyt, Belmont; Eldin V. Lynn, Massachusetts College of Pharmacy; William B. Meldrum, Haverford College; Edna M. Robbins, Mary C. Wheeler School; Theodore C. Sargent, Swampscott; Howard A. Smith, Milton High School; Paul F. Stockwell, Brattleboro High School; John R. Suydam, St. Mark's School; Ann C. Voter, Middlebury; P. Conant Voter, Middlebury College; Elbert C. Weaver, Phillips Academy; Bruce V. Weidner, Middlebury College.

The following persons have attended every summer conference: Charles E. Dull, Mary B. Ford, Mr. and Mrs. Gover C. Greenwood, Mr. and Mrs. F. Walter Hoyt, Alfred R. Lincoln, Evelyn Murdock, Norris W. Rakestraw, Elsie Scott, John R. Suydam, and Elbert C. Weaver.

NEW MEMBERS

Miguel Amat, Massachusetts Institute of Technology, Cambridge, Massachusetts
J. W. Boozer, Wafford College, Spartanburg, South Carolina
Inez L. B. Clough, St. Margaret's School, Waterbury, Connecticut
A. J. Currier, Pennsylvania State College, State College, Pennsylvania
E. W. Cook, American Cyanamid Company, Stamford, Connecticut
Edward M. Collins, Illinois College, Jacksonville, Illinois
Wm. F. Ehret, Oradell, New Jersey
Vilda Gegenheimer, Russell Sage College, Troy, New York
Betty Gushee, Hofstra College, Hempstead, New York
J. M. Hendel, Hunter College, New York City
David I. Hitchcock, Yale University School of Medicine, New Haven, Connecticut
Norman J. Kelley, Waterville High School, Waterville, Massachusetts
Doris E. McCausland, Nasson College, Springvale, Maine
Morris Meister, Bronx High School of Science, New York City
Pearle R. Putnam, Dean Academy and Junior College, Franklin, Massachusetts
John K. Rouleau, Boston College, Boston, Massachusetts
Dorothy D. Thompson, Sweet Briar College, Sweet Briar, Virginia
Charles E. Vose, Brattleboro High School, Brattleboro, Vermont
Ruth M. Wimmer, Fort Wayne, Indiana
Arthur A. Vernon, Northeastern University, Boston, Massachusetts
John S. Collier, St. Paul's School, Concord, New Hampshire

NOTES

Lorne F. Lea of the St. Paul's School has resigned as Chairman of the Northern Division because of ill health. The Executive Committee has appointed Lester F. Weeks of Colby College to fill his unexpired term.

Paul F. Stockwell of Brattleboro High School has been appointed Chairman of the Ninth Summer Conference Committee. The meeting place has not yet been selected.

SCHEDULE OF MEETINGS, 1946-47

October 19: Colby Junior College, New London, New Hampshire
December 7: Boston Area (Joint meeting with the Eastern Association of Physics Teachers and the New England Biology Teachers Association)
February 15: Providence Area
March 22: Hartford Area
May 10: Boston Area (Annual meeting)

EDITOR'S OUTLOOK (*Continued from page 469*)

All of this has application to business close at hand. Our reaction to it will determine the voice which scientists raise concerning legislation now pending: the establishment of a National Science Foundation and the particular provision which it makes for research in military science; domestic and international measures for the control of "atomoclastic" energy; the post-war draft and the occupation of enemy countries. Maintenance of our armed forces at a high level of efficiency can be consistent with a policy of exemption of scientists and others whose contribution to national defense can be more vital than the wearing of an M. P.'s brassard. We will certainly fight for that principle, above everything.

RECENT BOOKS

THE CHEMISTRY OF THE CARBON COMPOUNDS. VOLUME III, THE AROMATIC COMPOUNDS. *Victor von Richter.* Edited by *Richard Anschütz.* Newly Translated by *A. J. Mee.* Third English Edition based on the Twelfth German Edition. Elsevier Publishing Company, Inc., New York, 1946. xviii + 794 pp. 14 × 21.5 cm. $15.00.

The Richter Organic Chemistry texts—through twelve German, three English, and three American editions—have become a recognized and essential part of most chemistry libraries. The twelfth German edition, in six volumes, made its appearance from 1928 to 1935, inclusive. Soon after the appearance of each German volume a systematic translation and revision of each was published in the English language. A synoptic table of comparison of the latest German and English editions is as follows:

	Twelfth German Edition		Third English Edition	
Subject	*Volume*	*Year of publication*	*Volume*	*Year of publication*
Aliphatic compounds	I	1928	I	1934
Alicyclic compounds	II, part 1	1935	II	1939
Natural products	II, part 1	1935	II	1939
Aromatic compounds	II, part 2	1935	III	1946
Heterocyclic compounds	III	1931	IV	1946
Free radicals	II, part 2	1935	IV	1946

The outbreak of the European War in 1939 interrupted the completion of Volumes III and IV. Many of the chemists employed on the project, because of wartime duties, were forced to abandon or greatly curtail their activities. The publishers, nevertheless, felt obliged to provide the purchasers of the first two volumes with a complete set, as well as to meet the great demand for this treatise. They therefore decided, rather than have the third English edition incomplete, to publish a literal translation of Volume II, part 2, of the German text without revisions and addition to the literature. Volume III of this series, therefore, constitutes the larger portion of Volume II, part 2, of the corresponding German work. The section on organic free radicals has been shifted to the end of Volume IV, where it probably logically belongs. One new feature of the present English edition is that the references are now given to the original journals rather than to *Chemisches Zentralblatt;* names of the authors have also been added.

These volumes, including number III, are perhaps rather comprehensive and expensive for elementary organic student use. For more advanced classes and reference use, there are probably few that are equal to and none that are better than this series. This Volume III, as an integral part of an important series, will undoubtedly continue to hold its numerous old friends and to win many new ones.

RALPH E. DUNBAR

NORTH DAKOTA AGRICULTURAL COLLEGE
FARGO, NORTH DAKOTA

COLLOID CHEMISTRY: THEORETICAL AND APPLIED. VOLUME VI. GENERAL PRINCIPLES AND SPECIFIC INDUSTRIES; SYNTHETIC POLYMERS AND PLASTICS. Edited by *Jerome Alexander.* Reinhold Publishing Corporation, New York, 1946. vii + 1215 pp. Illustrated. 15 × 23.5 cm. $20.00.

Volume VI, like its excellent predecessors, seems more like a small library than a single volume. The area covered is impressive and yet treatment of the numerous topics, in most cases, is quite thorough.

Especially noteworthy is the rather unusual subject, "Phycocolloids: Useful Seaweed Polysaccharides," by C. K. Tseng. The 104 pages allotted to this topic are well done by the author.

Harkins, as usual, is thorough and detailed in Part II of his series on "The Surfaces of Solids and Liquids and the Films That Form Upon Them."

"The Physical Chemistry of Dyeing," by E. I. Valko, is another outstanding paper, useful in the textile industry and stimulating to many scientists. Two good papers, long hoped for by the reviewer, are "Colloidal Behavior in Metals and Alloys," by R. S. Dean, and "Colloidal Features of Drilling Fluids," by D. H. Larsen.

Fischer and Gans undertake an ambitious program in attempting to cover "Dispersions of Finely Divided Solids in Liquid Media" in 42 pages, but they succeed in making the subject interesting and useful. Included in this section are colloid grinding, sedimentation, heat of immersion, and the effects of surface-active agents.

"Colloid Chemistry of Clay Minerals and Clay Films" is ably presented by Hauser and leBeau, aided by excellent diagrams and photos. A. M. Gaudin gives a short but authoritative discussion of "Flotation."

"Catalysis and Its Industrial Applications," by P. H. Emmett, is good reading as are sections on silicones, ion-exchange resins, zein, synthetic rubber, insecticides, adhesives, soybean lecithin, laundering, centrifugals, lubricating greases, and several other topics.

Part II, some 344 pages, is devoted to "Synthetic Polymers and Plastics." It covers the field well as shown by chapters on the cellulose types, phenolic resins, urea resins, and other resins termed alkyd, furan, borated, allyl, and acrylic. Nylon, polythene, and polystyrene are also included.

With so many authors the treatment is uneven, but the general average is so high that the reviewer does not hesitate to urge every colloid chemist and most industrial chemists to buy this excellent book.

HARRY N. HOLMES

OBERLIN COLLEGE
OBERLIN, OHIO

INDUSTRIAL PLASTICS. *Herbert R. Simonds.* Third edition. Pitman Publishing Corporation, New York, 1945. x + 396 pp. 15.5 × 23.5 cm. $5.00.

This book, as the title indicates, describes the physical properties, methods of manufacture and fabrication, and the industrial applications of the commercially important plastics. It provides a very convenient collection of a large amount of information pertinent to the plastics industry. The style is clear and direct; the language is largely nontechnical; the book can serve the layman as well as the expert.

The generous use of photographic illustration and the inclusion of many tables of useful data effectively support the text of this book, giving reality and authority to the descriptive statements.

The discussion of plastic materials is strictly nonchemical throughout this book, except in the last chapter which is entitled "Chemistry of Plastics." Here in 18 pages the underlying chemical reactions are presented for eight major chemical types of plastics and, in bare outline, the chemical preparation of seven newer commercial resins. This may appear to be a too highly condensed (or polymerized) treatment of the chemical aspect of plastics, but the purpose and value of this book is in another direction. It may for this reason be recommended to chemists as complementary to a treatise on the chemistry of plastics.

The chemist with an historical sensitivity may be somewhat perturbed by the statement in this book (p. 48) "Urea . . . being in fact one of the first chemical substances to interest mankind. Medieval chemists were aware that all living substance consists principally of the four elements: oxygen, hydrogen, carbon, and nitrogen."

HARVEY A. NEVILLE

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA